THE ENGINEER

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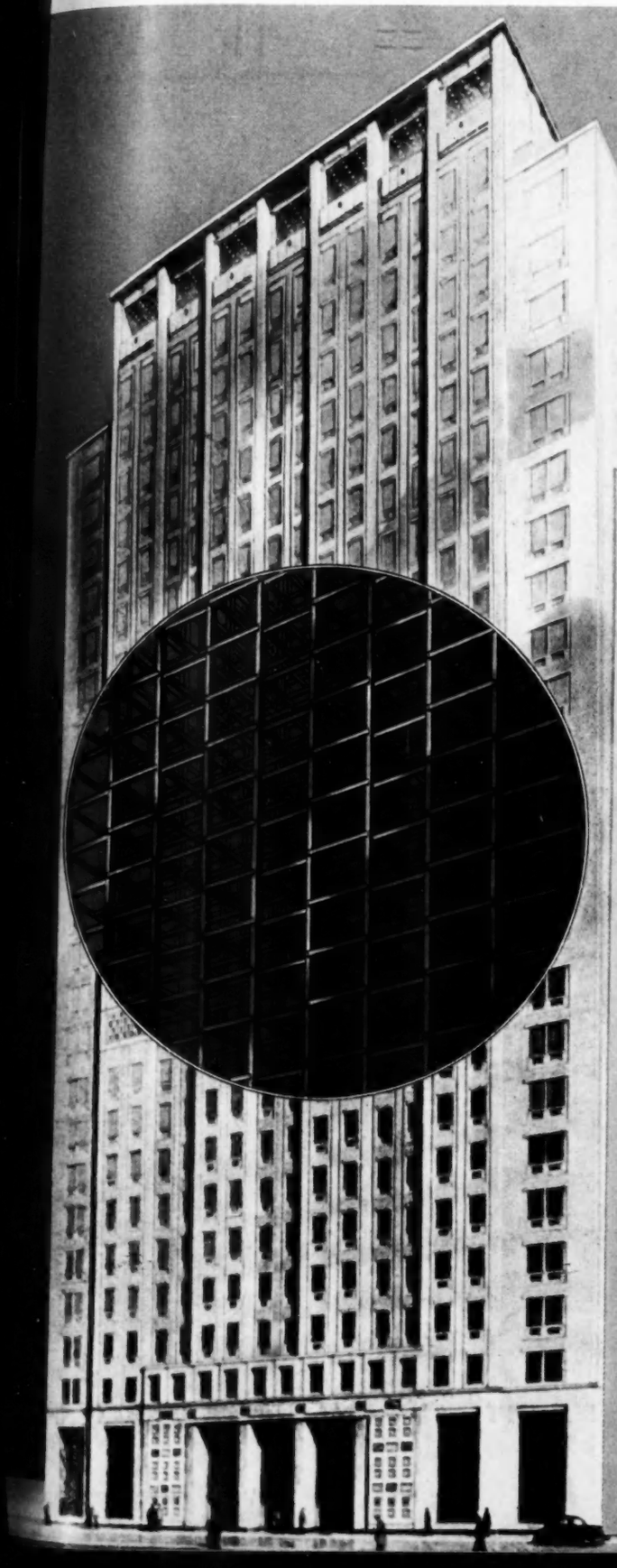

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THE ENGINEER

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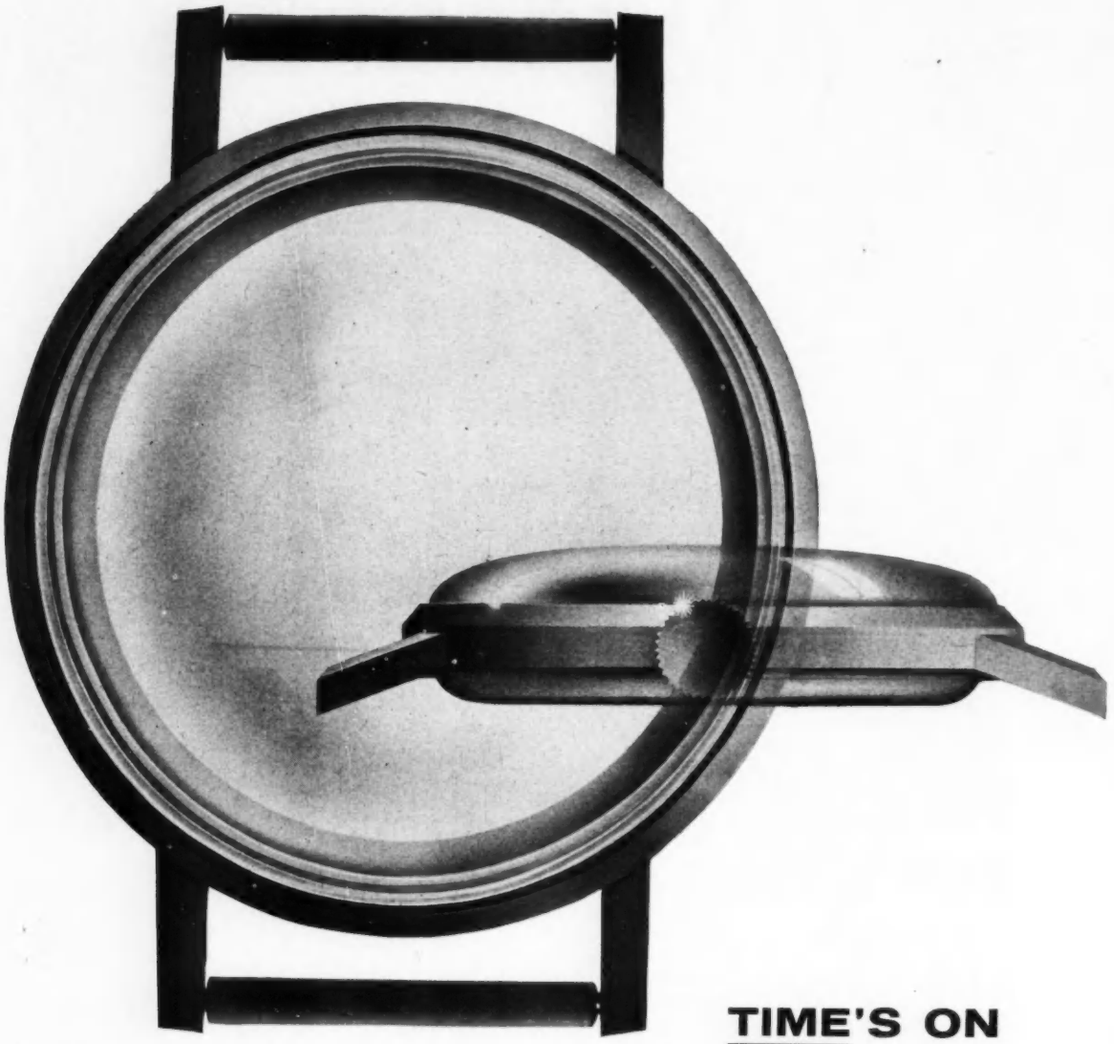

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THE ENGINEER

No. 5521 NOVEMBER 17, 1961 Vol. 212

NO NUCLEAR MERCHANT SHIP

It is over two-and-a-half years since the Government announced that eight designs of nuclear reactors for merchant ships, submitted from different sources, were to be examined. Models were made and later systems were subjected to a more detailed examination, and comparative studies were made to determine which of the several plants should be recommended for application to the propulsion of a merchant ship. The assessment made by the Galbraith Committee resulted in the recommendation of the boiling water and organic liquid moderated reactors for further examination and invitations to tender were sent out. Since then the Government has been questioned about the receipt of tenders and has suffered constant prodding to expedite the placing of a contract to build a marine reactor and to install it in a merchant ship; and the long delay in the appearance of any Government announcement about its intentions has caused many shipbuilders and engineers to have second thoughts about keeping nuclear design teams in being. At the recent James Watt Dinner of the Institution of Engineers and Shipbuilders in Scotland Sir William Cook of the Atomic Energy Authority stressed how completely uneconomic for marine propulsion is the present concept of nuclear design and he emphasised that only slow progress could be expected to be made in the development of less costly reactors. In comment, we deplored the prolonged hesitation of the Government and expressed the opinion that it was high time a definite decision was reached.

The prolonged period of gestation is now over. Last week in Parliament the Minister of Transport, in answer to a question, said that the Government had considered the advice tendered by the Committee on the Application of Nuclear Power to Marine Purposes and its Technical Committee and that that advice, while acknowledging the present feasibility of building a nuclear powered ship, pointed out that the project was definitely not an economic one. Mr. Marples announced that in the light of this advice the Government had decided not to build a ship but to undertake ashore a vigorous research programme directed to the development of an economic marine reactor. That decision will disappoint many people and disillusion others and it is fair to say that the Government has taken an unconscionable time reaching it. But nevertheless, it is probably the right decision. For though there are many problems to be examined besides those of the actual reactor performance, relating, amongst others, to the ship structure, the containment vessel, the movements of the ship in a seaway, the shielding of the crew, fuelling and defuelling, and collision damage, all of which were recently discussed in a paper on "Lloyd's Register of Shipping Rules for Nuclear Ships",* (not to mention corollary problems of safe navigation in areas where collisions tend to be frequent, legislation to ensure safety in harbours, etc.) the main hurdle to be surmounted is the economic one. Is it worth while expending much effort on examining such problems by sending a nuclear powered ship to sea when no economic reactor is in sight? The order of size of the hurdle can be gauged from the remark at the James Watt Dinner of Sir William Cook that it would be necessary to halve the cost of nuclear engines and reduce the fuel bill by a third before nuclear power would be on competitive terms with a modern steam turbine installation! Such figures clearly indicate that more fundamental research ashore is essential, whether or not a prototype reactor is sent to sea. The early development of a nuclear power reactor able to operate economically afloat would be an achievement which would rebound to this country's credit and be of great prestige and commercial value. It will surely be time enough to start building a nuclear powered merchant ship when that development is approaching success. In the meanwhile we hope the Admiralty will continue to experiment with nuclear power for the propulsion of submarines. Since for warships nuclear power has special advantages which may in part outweigh its unattractive economics it is, perhaps, permissible to hope that the Admiralty may also consider its application to surface vessels.

AN OUTSPOKEN PRESIDENT

When Sir Herbert Manzoni gave his presidential address to the Institution of Civil Engineers last year, we said, in comment, that "it is not often that a president, in his address to a major engineering institution, has something really exciting to say." Sir Herbert spoke of the influence and leadership which civil engineers are able to wield in these modern days, and gave his view that "as a profession we have become immersed in the minutiae of schemes conceived by other people and have forgotten how or have no time, or have lost the inclination, to take the lead, as far as that is possible in modern conditions, in promoting ideas and projects of our own conceiving." His statements were, in fact, quite a challenge to the profession, as to how it should order its affairs and its conduct in the future.

That challenge was taken up again on November 7 when the new president of the Institution, Sir George McNaughton, delivered an address equally exciting, and perhaps more outspoken, than Sir Herbert's address last

* By J. M. Murray and H. N. Pemberton. The Joint Panel in Nuclear Marine Propulsion. February 28, 1961.

year. A very similar tenor runs through the addresses of both the presidents. The two following on each other indicate that there is quite widespread and serious concern for the future, that civil engineers in particular, but indeed all chartered engineers, need to stir their stumps and take a critical look at their professional activities, to find out whether, in the future, they will be able to provide the broadest, most humanitarian, leadership for the community in those fields where their special training and experience is valid. In Sir George's words "The layman with whom the ultimate decision often rests is generally unable to assess engineering merits and is forced to judge the worth of a scheme on the engineer's obvious general knowledge and breadth of view. If he is lacking in these attributes it may be that, no matter how good the engineering conception may be, the scheme will receive less support than it merits. We cannot compel society to accept the engineer as one competent to express views over a wide field but we can earn the right to do so." Several matters of immediate policy which bear on this general attitude to the worth of engineers in society were commented upon by Sir George, and are to be found in the abstract from his address printed on pages 787 and 788 of last week's issue of THE ENGINEER. Amongst them was his call for a more broadly-based general education for all those taking up civil engineering as a career, and for more substantial funds for civil engineering research, and, more controversially, his suggestion that there should be an institution of chartered engineers formed by the combination of the three major institutions, or, as a step to that end, the formation of "an overriding high-level co-ordinating board which would speak for the three institutions on all matters of public interest and policy." This is clearly a policy which the best interests of all professional engineers demands, and those who speak of "take-over bids" of one institution by another are surely sacrificing broad gains for parochial ends. The particular contribution — which should not be undervalued — which the smaller institutions make to the life and affairs of the corporate engineering community need not, we think, be lost, nor even impaired, if such a policy as that propounded by Sir George were implemented.

One other matter of especial interest on a national scale was referred to by the president, namely future legislation for conservation of the country's water supplies. There has been much talk and discussion on this matter already, though not in public, and Sir George's statement of the lines along which future legislation is likely to run will be read with much interest. It would appear from his remarks that a broadly-based engineering approach to the problem is at the root of the proposals, and the duties suggested for the water conservation authorities which would be formed appear to be well conceived.

FEWER STRINGS FOR BEECHING

Much has been written critically about the high salary which Dr. Beeching receives as Chairman of the British Transport Commission and Chairman designate of the British Railways Board. In a speech to the Institute of Transport on November 7 he revealed, by implication, that his services are likely to prove well worth it. For he breathed a good deal of fresh air into the stale road-rail controversy. "Does the break-up of the Commission mean abandonment of the idea that various forms of transport should be co-ordinated? Will it lead to more wasteful competition?" he asked; and he replied to his own questions with an emphatic negative. For to him co-ordination means "avoidance of that condition when all forms of transport are competing blindly for all forms of traffic." It is not necessarily true in Dr. Beeching's opinion that co-ordination has not been achieved as Socialists believe, because there has never, for long enough, been a unified control of the whole industry. Nor in his opinion is it true that it has not been achieved, as Conservatives think, because competition has not been sufficiently free. The root cause of the trouble "is the failure of the industry to collect the knowledge without which sensible co-ordination is impossible."

This attitude of mind bodes well for the future of the railways once the new Transport Bill*, just laid before Parliament, becomes law. For what Dr. Beeching is saying is that neither railwaymen nor road operators know nearly enough about transport possibilities as a whole. It is easy enough to recite parrot cries about each form of transport carrying the traffics it is best fitted to handle. But what forms of traffic are different kinds of transport best fitted to handle? Dr. Beeching proposes to find out, interpreting "best-fitted" in terms of quality of service as well as of cost. The enquiry requires that methods of traffic costing on the railways which have already been developed shall be further improved and refined. In addition, quoting Dr. Beeching's own words "a whole series of studies are being made with a view to determining what the railways can do better, or ought to be able to do better than other forms of transport, and also to determine how much business favourable to railways there is and where it is to be found." On the basis of these findings the railways should be able to get out of business which is unsuitable and to get more of the business which they can handle best. On the same basis it should prove possible to foresee better how to modernise the railways so as not to throw money away on improvements which can never hope to earn their keep and so as to concentrate expenditure upon the improvement of routes along which traffic best handled by railways will flow. It is just this objective cold-blooded approach to railway problems, so conspicuous in Dr. Beeching's thinking, which we often find lacking amongst railwaymen, who seem, indeed, often only too willing to be deceived by their own propaganda.

The railways were constructed in an age when road vehicles were hauled by horses. Now that motor vehicles exist and now that a system of high speed motorways, paralleling the railway main lines, is being constructed, upon which, no doubt, there will soon run commercial vehicles designed for higher speeds than those ruling to-day, it is inevitable that the railways must lose many of the traffics they used to carry and that a, perhaps substantial, proportion of the route mileage will never again be able to earn a profit. Dr. Beeching sensibly proposes not to fight to retain all traffics, not to compete at a loss just for the sake of competing, but to find out as exactly as possible what part railways can profitably play and should play in an inland transport world which is bound to become increasingly dominated by road vehicles, and, for the long distance carriage of passengers, by aircraft. He clearly believes, as we believe, that railways can and should survive in Britain. Under the terms of the Transport Bill which splits up the B.T.C. "empire" amongst a British Railways Board, a London Transport Board, a Docks Board and an Inland Waterways Authority and which may have its second reading before Christmas, fewer strings will tie the hands of Dr. Beeching than tied those of his predecessor in control of the railways. Common carrier and other statutory obligations of the rail-

* A bulky document of 158 pages. H.M. Stationery Office.

ways will be swept away. Except in London the railways will be able to raise fares without reference to a tribunal. There will be greater freedom to close uneconomic lines. It will be possible to dispose of or develop land for non-railway purposes. And so on. This is to the good. If the railways are to survive as a profit-making part of the whole transport system they need to be freed of the shackles laid upon them when they were a dangerously powerful monopoly. Almost all engineers, we think, will hope that the chilly douche of Dr. Beeching's hard-headed sense will carry the railways back to prosperity.

KEEPING FISH FRESH

On Tuesday and Wednesday last week a Conference was held at the Humber Laboratory of the Department of Scientific and Industrial Research at Hull on the control of fish quality, and the two subsequent days were Open Days at the Laboratory. The Humber Laboratory is a subsidiary of the Torry Research Station at Aberdeen. The researches of both these laboratories begin at the moment when fish come over the side (or in the more modern style over the stern) of a fishing vessel. They are interested, that is, in dead fish and the means of keeping them in good condition until they reach the consumer. Much of this work lacks engineering content though engineers, as eaters of fish, may still be interested in it. There is for example the matter of defining quality — how fresh or how far from fresh a particular sample is — by sampling methods and by chemical means; there is biological research into the bacteria which attack and break down the flesh of fish; and, on the more practical side, the advice given to all who handle fish to use more ice and use it better. The laboratories have shown that to pack a typical fish box with fish and place a layer of ice on top is far less effective in keeping down the temperature of the fish than laying them between layers of ice top and bottom. They have a number of such practical suggestions to make.

But engineering keeps creeping in. Even packed in ice fish go bad — too bad to eat — within about sixteen days. The consequence is that if a distant water trawler makes a trip lasting over about three weeks the earliest part of its catch is likely to be condemned as unfit for human consumption when landed. One answer to that problem is to make the trawler move faster so that it can get back to port more quickly from its fishing grounds, which is a part of the reason why trawler skippers have an abiding desire for fast trawlers. The laboratories have been pursuing another answer. If fish is hard frozen — down to well below zero Fahrenheit — it can be kept for months. That fact accounts for the idea of the factory mother ship to which trawlers can transfer their catches. But in rough weather transfer can prove a tricky business. Instead the research stations are pioneering the development of what is known as a vertical plate freezer which can be installed in a trawler and operated by the crew. Curiously enough, though there are now several vessels using this idea in one form or another at sea, no owner has yet dared so to defy custom as to sample the concurrent saving to be obtained in running costs by ordering a slower trawler. A consequence of this development has been the need to provide thawing equipment ashore and plant of this kind using the dielectric principle is now being manufactured. Another likely development is the erection of deep-freeze cold stores at fishing ports into which the deep-frozen catch could pass, thereby providing a cushion against times of glut and scarcity.

Much fish is eaten smoked. Here again engineers have been busy. Few, if any, traditional kilns are now built. Instead the Torry kiln of which over a hundred are now in use is chosen. It is labour saving and, by ensuring even distribution of the smoke, it yields a more uniform product. A nice problem is set engineers in the design of smoke generators for such kilns. At the Humber Laboratory there is being developed a "fluidised" sawdust smoke generator. The problem to be solved appears similar in some respects to that of burning pulverised fuel — except that the fuel must never burst into flame or even glow! But all this work may eventually prove abortive. It has been discovered that the smoke has very little, if anything, to do with smoking. Instead invisible vapours dissolve in water present on the surface of the fish and the resulting solution then diffuses into the tissues. Thus it seems possible that the smoked salmon of the future will never have been near any smoke. It will just have been dipped into a solution and hung up to dry! No doubt engineers will mechanise the whole operation and no doubt smoked salmon will be cheaper. But, we cannot help wondering, will it be quite the same? We are prepared to trust to scientists to determine how far from freshness to unfitness for human consumption a sample of fish has gone, even though they do so by tasting it. But a committee of chefs, gourmets and epicures would be far better fitted to pronounce upon the merits of dipped as opposed to smoked salmon!

The Engineer—100 Years Ago (NOVEMBER 15, 1861)

Machinery for Rolling Iron

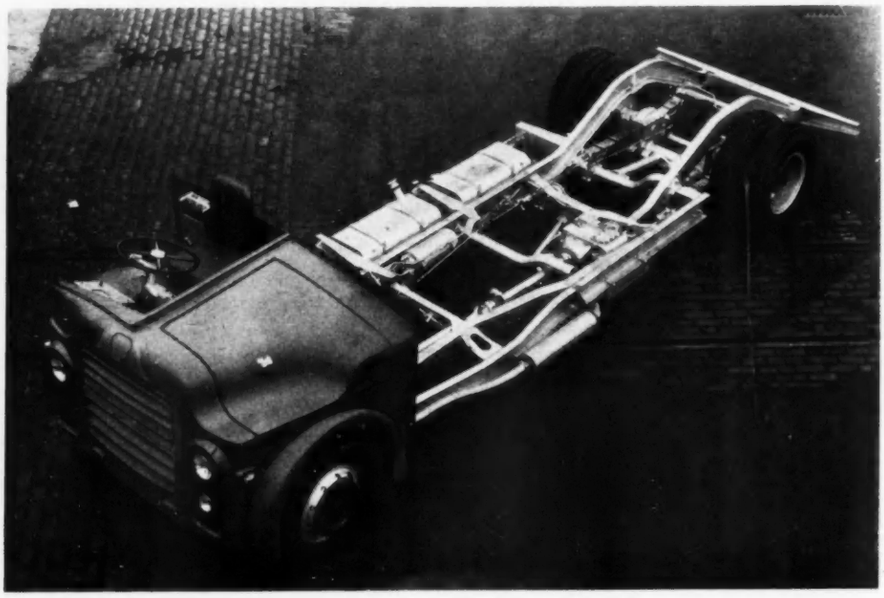
One of two things which limited the size of girder, section or plate which could be rolled from iron was the size of bloom which the traditional iron-making process could produce. Bessemer's process offered a solution to this problem but left the second unchanged. This second difficulty was the fact that man's physical strength imposed a limit on the size of the piece of iron which could be manipulated at the rolls. It is true that some large plates had been rolled by teams of men working under difficult conditions, but this sort of operation was and had to be, an exception. J. G. N. (later Sir John) Alleyne of Butterley, Derbyshire, patented a method of working in 1861 which solved the second part of the difficulty. He fixed contra-rotating engines at opposite ends of a mill train, with clutches so arranged that either engine could drive the rolls. By reversing the direction of the rolls work could be done in both directions and handling was reduced. This was a useful arrangement, though it was in time to be superseded by the much simpler direct-reversing engine.

Of greater significance for the future was the ancillary equipment for handling the iron as it was rolled. Alleyne had iron carriages running parallel with the rolls both in front and behind them, and sunk so that their surfaces were at floor level. These carriages were traversed across the line of rolls by steam or hydraulic power, and afforded a convenient means of transferring the iron from one pair of rolls to another as rolling proceeded. Here was the mechanised mill of today in embryo.

Kelvin Hall Motor Show

The Scottish Motor Show opened last Friday and closes tomorrow. It was the occasion of the introduction of rather few new vehicles but of a number of developments in engines, transmissions, and equipment.

THE forty-third exhibition of the Scottish Motor Trade Association was opened at the Kelvin Hall, Glasgow last Friday by the Right Honourable Lord Polwarth, T.D., C.A. This is the only exhibition this year in Great Britain to include commercial vehicles, and many of the new products on show were for goods transport or public service.



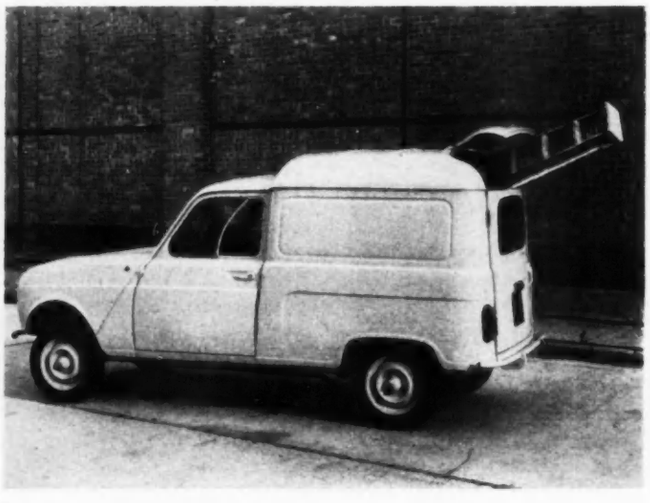
The chassis of an Albion "Lowlander" low-height double-decker. One of the two secondary reduction gear trains in the cranked driving axle can be seen, with, in front of it, the anti-roll torsion tube. On the cross-member at the back of the gearbox is mounted the air motor for the handbrake. with the control valve in the link above and before it

The predominant, and for many years the only, motor manufacturer in Scotland, Albion Motors Ltd., has introduced a double-decked low-bridge omnibus, the "Lowlander." This is a seventy-two-seat vehicle with dimensions of 30ft long by 8ft wide by 13ft 5⅞in unladen, but is mechanically quite distinct from the other high-capacity low-height vehicle marketed by the Leyland Group, the "Atlantean" (see page 338, Sept. 7, 1956, and page 518, Oct. 3, 1958). The "Lowlander" is superficially of the conventional half-cab design, but the chassis, transmission and rear axle are specially designed to allow the gangway of the lower deck to be reached with but one, albeit high, step. The lower deck is sufficiently low for the upper deck to have the normal centre gangway, but because the driver is seated over the front suspension the front row of seats in the upper saloon have to be higher than the remainder. The "Lowlander" incorporates a cranked double-reduction driving axle like that of the original "Atlantean," a two-stage gear train with a speed increase of 0·85 to lower the transmission line behind the clutch, and a two-piece shaft with intermediate bearing between power unit and gearbox. It is of course intriguing that the Leyland Group should introduce a second and quite different design for a single purpose, the more so as the new vehicle is closely similar to machines already on the market; the existence of a strong demand for vehicles of this configuration may be due to the fact that low-bridge vehicles normally constitute part only of a fleet, and it is convenient for servicing, crew training, and so on if the low-bridge equipment is not radically different from the remainder.

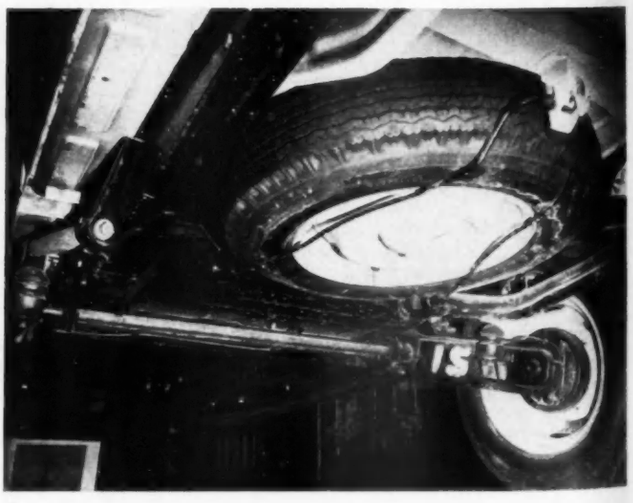
The chassis of the "Lowlander" is seen in our illustration, which shows such details as the anti-roll tube before the rear axle and the air-power-assisted handbrake. The vehicle exhibited had a "Pneumocyclic" transmission driven through a fluid coupling with lock-up by a centrifugal friction clutch, but a synchromesh gearbox is also offered. There is also a choice of body arrangements, with the entrance behind either the front or rear wheel; in the former case doors are fitted, operated from the driver's cab. The lower saloon has the seats on raised platforms each side of a narrow walkway that passes through the "throw" of the cranked axle. An unusual detail is that the bonnet, of which only the top opens, has no catch, and is spring-loaded through an over-centre mechanism which causes the spring to hold the bonnet both open and shut; the emergency fuel shut-off is within this bonnet, but with the exception of this screw-down valve the engine is effectively withheld from reach by the radiator in front and the wheel on the near side.

Some of the "Lowlander" chassis already ordered provide for self-levelling (air) suspension at the rear to hold the unladen height down to 13ft 4in.

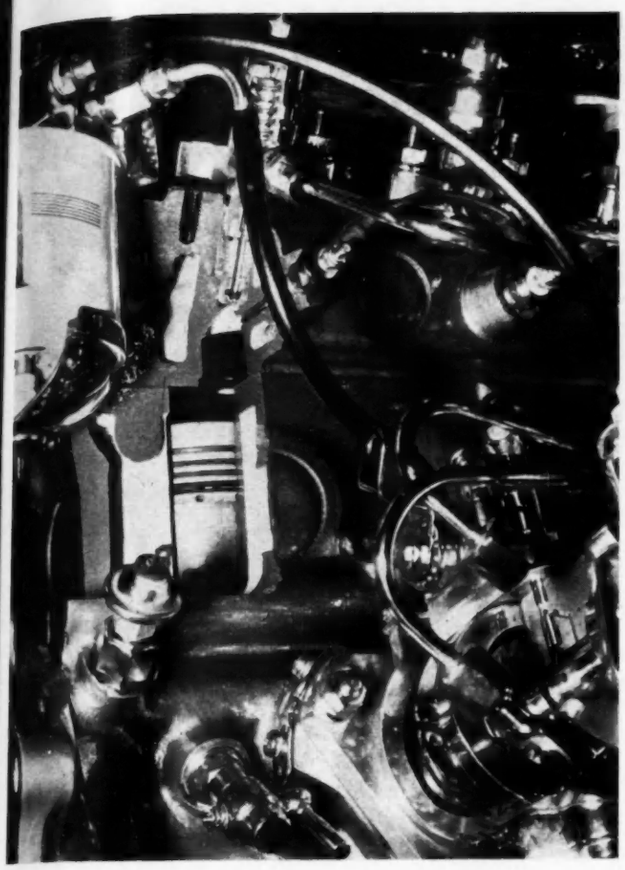
The show was the occasion for the introduction of the van version of the Renault "R4," called in English-speaking countries the "Fourgon." It will be recalled that in the R4 minor servicing has been reduced to changing the engine and transmission lubricants and attending to the accumulators, so that the van version may well appeal to operators whose fleet is too small to allow spare vehicles to be kept to do the work of those which are off the road. The van is



The new Renault "Fourgon" can carry a 6 cwt payload in a 66 cubic foot body, with a kerb weight of only 12¼ cwt. Ground clearance of nearly 8in and long-travel independent suspension all round give it "go-anywhere" qualities

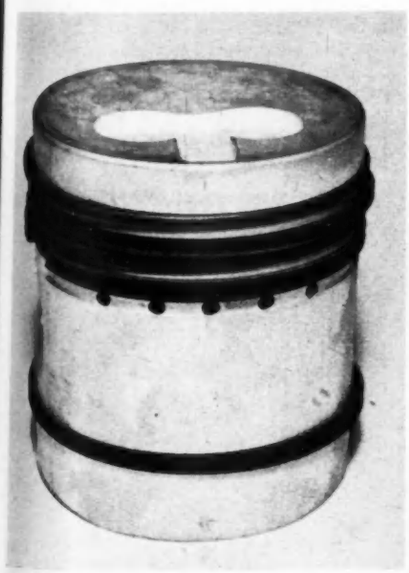


To avoid interrupting the flat under-surface of the "Fourgon," the space for the fuel tank and spare wheel is subtracted from the load volume. Notice that the filling spout is the lowest point in the fuel system



Sectioned example of the B.M.C. "B" series engine in compression ignition form : the D.P.A. pump displaces the distributor of the petrol engine. The fifth piston ring can just be seen near the bottom of the piston. Notice the sheathed element heater plugs wired in parallel

very closely like the car, but whereas on the car the middle of the roof opens to admit bulky objects, in the van the extreme rear of the roof, immediately above the door, can be either folded forward or removed and stowed inside. The depth of the load space is probably less than would be expected in a front-engine front-wheel-drive vehicle ; the fuel tank and the spare wheel have to be stowed between the flat under-surface and the floor of the body, and consequently the latter is several inches higher than the floor of the cab.

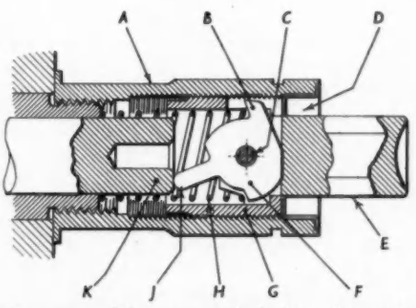


One piston of the B.M.C. "B" series engine in compression ignition form. The combustion system is a Ricardo "Comet V" with a nominal compression ratio of 23, so that the volumes of the space above the piston, in the swirl chamber and passage, and around the heater plug total only 17 c.c.

There have for some years been available for vehicle applications engines which, at the stage of initial manufacture, could be made for either spark or compression ignition. An innovation at the Show, however, was an example of such an engine produced by the British Motor Corporation, whose spark-ignition engines have the bores finished in the crank-case casting and main bearings only between each pair of cylinders. This novel concept of an oil engine has, however, been applied only to the second smallest petrol engine, the "B" model of 1489 c.c. ; the new engine is at present available only in 10/12 cwt. and 16/18 cwt. goods vehicles and the larger (ten or more seat) passenger vehicles, but the maker anticipates that it may eventually have as wide application as the petrol engine, and in many of the vehicles at present fitted with the "B" series engine the complete vehicle does not attain the life achieved by the conventional and, of course, more expensive diesel engine. The compression-ignition version has a stronger crankshaft than the spark ignition engine, which has necessitated a reduction in bearing length ; a torsion damper is fitted on the front. The cylinder head is a new component, containing combustion chambers designed for the K.L.G. sheathed element heater plug (see page 588, April 10, 1959,) and the compression ratio is nominally 23 : 1. The maximum brake mean effective pressure is 106 lb per square inch at 1900 r.p.m. and the peak power of 40 b.h.p. nett is reached at 4000 r.p.m. Fuel consumption characteristics are not available for the "B" series engines, but the new version has, it is claimed, a consumption only two-thirds that of an older model using the constant volume cycle at a compression ratio of 7·2 : since, however, the new engine has the advantage of greater fuel density, it is apparent that heat losses from a very small combustion system worked at high speeds are extreme. No cold starting performance is quoted.

The engine weighs 422 lb, 50 lb more than the spark-ignition unit ; the power/weight ratio is over 10½lb per horse power compared to 9 lb per horse power for the petrol engine—these figures are not for an installed unit, i.e. they exclude radiator, cooling water, &c.

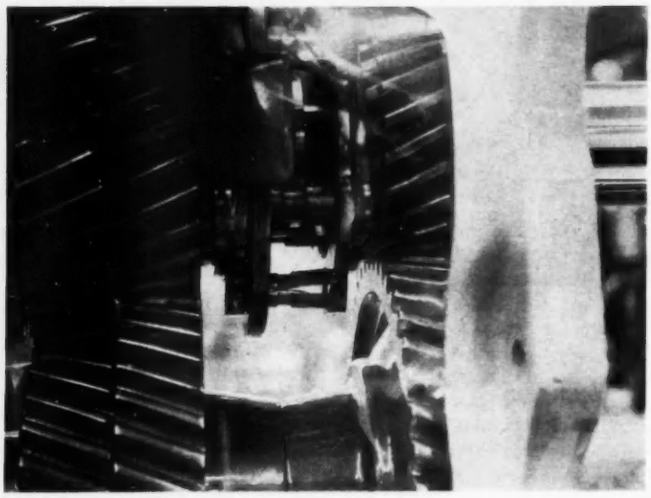
C.A.V. Ltd. has introduced for its camshaft fuel injection pumps an excess fuel device which in no way compromises the normal maximum fuel stop when the engine has been started. The method of operation can be followed by reference to our drawing. There is screwed on to the pump a body *A*, within which is carried the threaded bush *G*. In the bush plunger *E* slides against spring *H*, and pin *C* in the plunger locates trigger plate *B*. In the position illustrated, which corresponds to normal running, the trigger plate acts as a positive stop for the fuel rack *K* in the increase direction. If then plunger *E* is pushed in, the control rack is moved to the left until the lug *B* on the trigger plate reaches the bottom of the slot in the bush in which it is located, when further movement of the plunger causes the trigger plate to rotate clockwise and lug *J* enters the recess in the control rack ; the rack will then move to the right, but no further than the normal maximum fuel setting. When the plunger is released, its movement to the right is followed by the rack, and excess fuel is selected. If the engine is now started, as it gathers speed the governor will withdraw the rack, and when the rack is just below the normal maximum fuel setting spring *H* will return the trigger plate to its normal position. The maximum fuel setting is adjusted by twisting the plunger, which has a flat on it, and thus screwing the bush *G* in or out ; this adjustment is preserved by knocking in the expandable locking cap *D*, which prevents rotation of the plunger. The device will set the maximum delivery anywhere between 8 and 16mm, and gives a further 6mm travel in the excess fuel configuration.



"Tamper-proof" excess fuel device which automatically returns to normal operation after the engine has started

This 1750W generator has the silicon diodes enclosed within the case

There was shown by Simms Motor Units



Ford direct-top gearbox with fourth engaged : notice that the male cone of the fifth gear synchronising clutch is formed on the teeth of the main drive gear

Ltd. a new alternator, intended particularly for public service vehicles, which is capable of giving maximum output at the bottom end of the speed range, i.e. it will, if the maximum engine speed does not demand a step-up of less than about 2·3, carry the lamp load when the engine is idling. The basic alternator is of the form now becoming common with a three-phase star-wound stator and an imbricated rotor fed through slip rings. The three silicon diodes which rectify the output and the further three which suppress reverse current in the field after shut-down are housed in a compartment within the alternator, the silicon rectifier being capable of running at the elevated temperature prevailing within the machine. The whole assembly fits on a normal 7in swing mounting, and has a rating of 1750W—70A cold and 60A hot at 24V. The weight is 50 lb, little more than half that of a d.c. equivalent.

There is now available on the Thames "Trader" and coach chassis a five-speed gearbox hitherto used only on Ford vehicles of United States manufacture. This gearbox incorporates synchromesh of a design, new to this country, which does not result in the dog clutches being far smaller than in a conventional gearbox. In the Ford synchromesh, seen in our photograph, the friction clutch is outside the dog clutch and can therefore be relatively large and lightly loaded ; it can be seen that the male face is, in the case of the smallest gear, at a larger radius than the roots of the gear teeth. The sliding clutch member, which is splined to the main shaft in the normal way, has a conventional dog clutch at a small radius and, outside it, a disc with a set of six holes. In three of these holes there are located pegs which are split along a plane containing the axis and forced apart by small leaf springs ; these pegs are waisted so that they tend to stay put when they project equally each side of the disc, and thus if the disc is moved axially the pegs tend to move with it. This causes the pegs to push the bronze female halves of the synchromesh clutches into contact with the cones, and if synchronism does not prevail the female will rotate with the male until it is arrested by the sides of three pillars on which it is supported meeting the edges of their three holes in the disc. These three pillars are deeply and sharply waisted, and until relative motion between the faces of the synchronising clutches ceases, the shoulders on these pillars will baulk the movement of the dog clutch into mesh. When synchronism occurs, the disc moves along the pillars between the female clutch members and the pegs are pushed part way through the disc. When the disc is pushed back again to disengage the dog clutch, the pegs will push the female cones back until contact is made with the opposite male clutch, but then the disc will continue back to the middle of the pegs and the pegs will spring apart and resume their functions of locating the female clutches both axially and radially.

This gearbox runs entirely on rolling bearings ; ball bearings locate the main drive gear and the back ends of the main and lay shafts, and needle roller bearings support the front of the lay shaft and the spigot of the main shaft. Such a construction allows continuous use of indirect gears, and the constant-mesh and high-indirect gears are keyed to the lay shaft to allow alternative assemblies to be built up with either three or four reduction gears. Since the lower gears are common to each build, the shift patterns must be different, and are in fact as follows :

Direct top—

4·38	1·48	—7·20
2·40	1	7·58

Overdrive—

3·50	0·799	—6·00
1·80	1	6·06

The spacing of the ratios is also necessarily different, the changes being, downwards, 1·48, 1·62, 1·83, 1·73 for the direct-top box and 1·25, 1·80, 1·95, 1·73 with the overdrive.

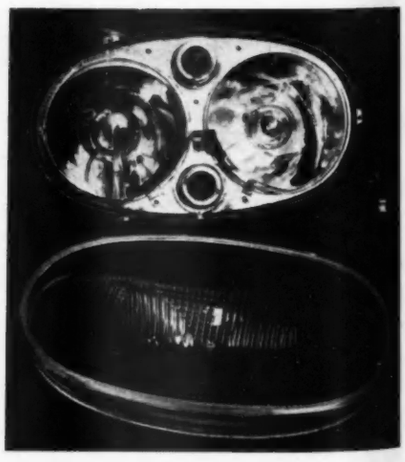
We have been afforded the opportunity to drive the new gearbox in its overdrive form in a Thames coach, and have found that the synchromesh is both powerful and effectively baulked ; deliberately over-loading it, or inadvertent changes from third to overdrive, brought forth no sign of protest. Only in the case of changes in to second was the driver sometimes aware of the baulk, the time to synchronise being of course disportionately longer in lower gears with the friction clutches on the output shaft. In an unloaded vehicle it was not possible to transmit full power through the straight-cut (sliding) gears for first and reverse, but with this reservation the box could be called silent. One obvious advantage of this design is that when the friction faces have worn so far that the baulking is ineffective, the changes will be quite easy because of the relatively large proportions of the dog clutches, and another advantage which we observed in driving it is that there is no risk of clashing the dogs if a clutchless change is made imperfectly.

The Dodge commercial vehicles at the exhibition displayed a new electrical accessory, an ice alarm called the "Icelert." This device is made by Findlay, Irvine Ltd., Bog Road, Penicuik, and is intended to be mounted about 15in above the road, facing forward ; as our illustration shows, it is surrounded by a reflector so that radiation falls upon it only from the forward hemisphere. No calibration of the instrument is necessary, it appears, and it is claimed that when the surroundings are at or about freezing point the warning light flashes on and off, while when the temperature is well below freezing the light is on continuously.

"Icelert" frost monitor fitted below the front bumper of a Dodge truck

The functioning can be visualised by imagining a bimetal strip included in the lamp circuit and set to close the circuit at 32 deg. Fah ; the current will heat the strip and cause it to open the circuit again unless the temperature is well below that at which it first closes. The particular function claimed for the "Icelert" is to give warning of isolated patches of cold road in, for instance, shaded stretches, of which a driver in a closed vehicle might remain unaware : the device was not demonstrated in action.

There was introduced earlier this year, on the Facel Vega "Facellia", a new four-headlight system and at Kelvin Hall it was for the first time possible to see one of these new Marchal lamp units dismantled. The example seen in our illustration is designed for mounting with the main lamps side by side, whereas the "Facellia" has the lights one above the other, but the construction, with four lenses formed in a single piece of glass, is apparent. This example has in each main lamp twin-filament bulbs containing filament shields, and in addition one lamp has a



One of the two units that comprise the forward-facing elements of the Marchal four-headlamp system

bulb shield. Notice that an extension of the reflector shields the lens opposite the turning signal bulb, so that it flashes on/off and never bright/dim. The advantages of this new design appear to be very significant ; it does sacrifice the centre of the reflector to render the light source removable, but this disadvantage is accepted by British (or at least English) designers without the compensating advantage. On the other hand, the departure from axial symmetry allows the lens and reflector to be made separately and aligned without error, the reduction to unity of the number of edges to be sealed allows the lamps to be packed more closely together, the unified assembly is easier to clean, only one hole is needed in the body, and, not insignificant, the appearance of the complete vehicle is improved. It might be thought that putting the side light in between the headlamps would demand that the whole assembly be placed very close to the side of the vehicle, where the danger of the lens being damaged is increased, but, of course, electrical systems designed on the Continent usually include separate parking lamps at the widest section of the vehicle. The exhibition did not include an example of a vehicle with head lights of a section other than circular in the transverse plane, but some idea of how the abandonment of axial symmetry can ease the problem of obtaining adequate forward vision for the driver can be gathered from the accompanying illustration of a Ford "Taunus" saloon : this is in fact a more ambitious design in some respects, in that the main lamps are protected by the bumpers and the side lights are placed so as to be visible through a wide arc.

An example of the trend to more sophisticated lighting systems is afforded by the current "Taunus" saloon

Non-Destructive Testing in Electrical Engineering

No. I

A conference on non-destructive testing in electrical engineering was organised by the Institution of Electrical Engineers and held in London from November 8 to 10. Many of the papers dealt with specialised aspects of the subject but some, which may be of general interest to other branches of engineering, are summarised below.

Examination of Materials

X-RAY analysis (as distinct from radiography) and electron microscopy can be regarded as non-destructive methods of examination in the sense that, although the need to obtain a suitable test sample involves some interference with the equipment under study, the sample required is usually so small that its removal does not prejudice the performance of the equipment. X-ray diffraction, electron microscopy and X-ray spectroscopy are three test methods that have proved useful by yielding distinctive information, as discussed in a paper by A. M. Adams, G. W. Smith, R. C. Stanley and P. W. Teare.

X-Ray Diffraction.—Basically this method of test depends on the three-dimensional periodicity (on the atomic scale) of crystalline substances. This frequency (in conjunction with X-rays of wavelength comparable with the distances between the atoms of 1–5Å wavelength) produces diffraction, in the same way as ruled gratings cause diffraction of visible light. In principle, therefore, any change in the spacing of atoms, caused, for example, by elastic strain or thermal expansion, can be measured by diffraction methods.

Such methods have been used in the Central Electricity Research Laboratories for about nine years. Since diffraction patterns derived from powders by the Debye Scherrer method provide specific means of identification for most solid compounds it was convenient to use this technique for corrosion products and contaminants. For example, a fracture in 0·004in diameter copper wire from a defective contactor coil was examined and a deposit on the fractured end of the wire was found to contain an an oxide, a hydrated chloride and an oxychloride of copper, as well as an unidentified compound, probably organic. The volume of the deposit analysed was about 5×10^{-8} cubic inches and its weight was estimated at about 3×10^{-7} grams. The presence of chlorides in this deposit suggested that acid perspiration had been left on the wire during manufacture.

This method of analysis has been found very useful in the identification of complex substances. In one instance traces of solid matter found in suspension in transformer oil were identified as calcium attapulgate—which is a kind of fuller's earth used as an oil cleaning medium.

During investigations into the failure of a steam turbine at Uskmouth power station in 1956 numerous X-ray examinations of deposits from the steam valve gear and of solids extracted from the oil centrifuges were made by C.E.R.L. and the turbine makers. The first diffraction patterns obtained from these studies yielded the main clue both to the composition and to the small crystallite size of the material deposited on the control piston of the valve gear. This information was a major factor in elucidating the complex sequence of events that led to the turbine breakdown.

More recently X-ray diffraction analysis has been used in metallurgical studies. For example, in work on grain-orientated steels, Lauë and others have used diffraction techniques to measure the orientation of individual grains in coarse-grained specimens, and to determine the distribution of preferred orientation in material of smaller grain size—the aim being to relate the magnetic properties to the material textures produced during rolling and subsequent heat treatment. In research work on the welding of austenitic steels attempts have been made to measure residual stresses by diffraction methods which, as stated above, can, in principle, be used to detect any change in the spacing of atoms.

Usually X-rays are the preferred form of electromagnetic radiation for diffraction work but electrons accelerated through voltages of the order of 10kV to 100kV show the characteristics of radiation having wavelengths between 0·12Å and 0·035Å. However, because the interaction between matter and electrons is more vigorous than that between matter and X-rays, the transmission diffraction effects can only be observed in thin films or small particles.

Electron Microscopy.—The development of new methods of preparing metal specimens for examination under the electron microscope has made this instrument almost indispensable in metallurgical research. The first method introduced by Smith and Nutting in 1956 is known as carbon extraction replication. In this process the metal surface is polished and etched and a carbon film is deposited on the surface by evaporation from a carbon arc. Then the metal is etched away under the film which is left free for examination. This treatment differs from simple replication in that inclusions are etched at different rates from the matrix and adhere to the carbon film where they can be examined by electron diffraction in the electron microscope. This technique has been applied to the study of austenitic steels used in the electricity supply industry, and examples were quoted in the paper.

The second method, known as thin-film microscopy, has been developed principally at Cambridge since 1956. A specimen of metal is machined or etched until it is about 0·015in thick. This stock is then electro-polished until parts of it are about 2000Å thick. These parts are examined, under transmission, in the electron microscope. Thin-film microscopy offers the following advantages compared with reticulation ; precipitates are examined *in situ*, with their size and composition unchanged by etching, dislocations and precipitate-dislocation interaction are revealed. This method has been successfully used in the examination of metal specimens taken from the superheater tubes of boilers in Brimsdown power station after twenty years of service.

X-Ray Spectroscopy.—From Moseley's work in 1914 it was evident that the chemical elements have characteristic X-ray spectra but this discovery has only recently been applied to quantitative analysis with the development, in the last years, of crystal spectrometers using counter detectors. This method of analysis depends on the use of an analysing crystal of known lattice spacing (whereby the wavelength of the emitted radiation can be determined easily from the measured angle of diffraction) and

scintillation or proportional counters which are sensitive to a wide range of radiation inten sities. Elements can be identified more readily than by optical spectroscopy because the X-ray spectrum is simple and is relatively independent of the state of combination of the element concerned. In addition the recording of radiation by counters makes the

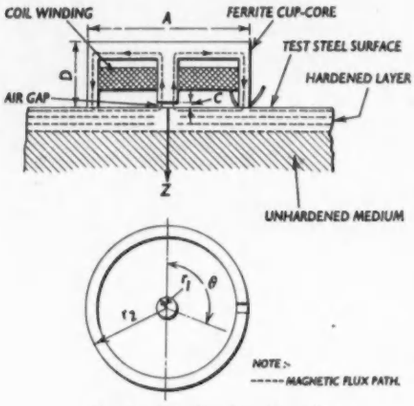


Fig. 1—Details of probe unit

method much more rapid than optical spectroscopy with photographic recording. Analysis of all elements heavier than magnesium is straightforward. But absorption problems and the difficulty of finding crystals with suitable lattice spacings makes it difficult to extend the method to the lighter elements which emit X-rays of comparatively long wavelength.

There are two main techniques using different methods of emission excitation. In one, known as fluorescent spectrometry, the specimen is subjected to a high intensity beam of polychromatic X-rays. Typical applications include the analysis of sulphur in lubricating oil additives (down to 0·01 per cent) and of the amounts of copper, chromium and arsenic in impregnated timber. In the second system electron bombardment is used to cause X-ray emission. Accordingly it can only be used with specimens that are stable *in vacuo* and it requires more preparation. However, since electrons can be focused into beams of diameter less than 1μm, areas down to 1μm^2 can be analysed.

Measuring Depth of Surface Hardness in Flame-Hardened Steels

Details of an investigation into an electrical non-destructive method of measuring the depth of surface hardness in flame-hardened steels were given in a paper by J. A. Butts and J. M. Newsome.

This work was started because there was no established non-destructive method for the measurement of depth of hardness, independent of the effects of chemical composition and quench procedure. The authors therefore investigated a method involving alternating currents and based upon the measurement of the complete impedance of a search coil magnetically coupled to the test surface by a ferrite cup core. This method depends on the fact that the electrical and magnetic properties of a hardened steel are functions of the pre-quenching temperature and of the kind of quench. Measurement of the electrical and magnetic surface properties of a flame-hardened steel would, therefore, give a measure of the depth of surface hardness. Such a method would be comparative for a given shape and composition of test specimen and would assume consistent quenching procedure and a fixed gas-burner configuration.

The product of resistivity and permeability of the test steel surface (termed the "electrical surface factor") can be measured in terms of the complex impedance of a coil which forms part of the probe unit shown in Fig. 1.

Flat flame-hardened steel surfaces were used throughout. Two techniques were examined, one using low frequencies (appoximately 5–500 c/s) such that the magnetic-flux penetration was significantly greater than the depth of the hardened layer, the other using higher frequencies (approximately 8–15 kc/s) such that significant magnetic-flux penetration was very much less than the depth of the hardened layer, as shown in Fig. 1. In an entirely experimental approach the first technique did not show successful results ; a theoretical examination of the problem, if it were possible, would require a knowledge of the variation of resistivity and permeability within the hardened layer. Encouraging results were, however, obtained with the second technique. A relationship was found to exist between the probe-coil electrical parameters and the depth of hardness, and this relationship was studied theoretically and experimentally.

The work covered by the paper is exploratory, and if the high-frequency a.c. method is to be developed it is necessary for the following factors to be examined :

(*a*) The variation of resistivity and permeability of steels with quenching temperature and severity of quench, and with depth below the surface of a surface-hardened material ; the possibility of ambiguity in the method may arise through $\mu\rho$ (where μ is the permeability and ρ the resistivity), having the same value for different depths of hardness.

(*b*) The behaviour of the relation between G_m and $1/\sqrt{f}$ with probes of differing dimensions where G_m is the conductance representing total power loss in the steel specimens.

(*c*) The development of probes of different shapes (e.g. U-shaped), possibly to deal with curved hardened surfaces.

Nucleonic Gauging

Nucleonic devices provide convenient and satisfactory means of gauging the thickness of materials, such as strip, foils and coatings, used in electrical engineering. Because a nucleonic gauge does not make contact with the material it is measuring it cannot affect the surface finish.

A typical installation is one used for the measurement and control of the thickness of aluminium foil. A radioactive source of thallium 204 or strontium 90 is mounted in a container fitted with a solenoid-operated shutter which, when closed, absorbs the β-radiation produced by the source and corresponds to an infinite thickness, enabling the electronic amplifier to be balanced at the maximum-thickness end of the measuring range. When the shutter on the source is opened, the β-particles (electrons) emitted by the source strike the surface of the detector and if no material is interposed in the measuring gap, produce a maximum output from the detector enabling the electronics to be standardised in the condition corresponding to zero thickness.

The detector usually takes the form of a sealed ionisation chamber filled with air or an inert gas such as krypton or xenon. A current proportional to the quantity of ionising particles entering via the thin-foil window is produced in the chamber and, passing through a very high resistance in series with the chamber, produces across it a voltage which is proportional to the intensity of the incident radiation. Any material between the source and the chamber absorbs an increasing number of the β-particles as the thickness increases, producing a corresponding reduction in the current flowing in the chamber. The proportion of the radiation absorbed by a given weight per unit area of material is a constant for the type of material being measured, and is proportional to the mean atomic number of the material. Hence the instrument can be pre-calibrated for a given substance. The current produced in the ion chamber is of the order of 10^{-9}A and the resistance used to convert it into a voltage of sufficient magnitude to be reliably measured is of the order of $10^{10}\Omega$.

Because of the very high source impedance, the d.c. amplifier required to produce the necessary power to operate the moving-coil indicators and control circuits must itself have a very high input impedance and this is achieved by using a semi-electrometer input stage with a maximum grid current of the order of 10^{-12}A. A d.c. amplifier is used because it is simple and reliable under industrial conditions. Since the smallest increment of thickness to be measured, about 0·5 per cent, corresponds to 0·1 per cent of the full-scale voltage, the zero drift of the amplifier must not exceed 0·02 per cent equivalent of full-scale deflection. This is achieved by careful design of the amplifier and comparatively elaborate stabilisation of the h.t. and l.t. power supplies. The resultant performance is such that a drift figure of 0·02 per cent over a period of a month is usually achieved.

On the other hand, variations in the weight of the air in the measuring gap due to ambient temperature variations can introduce errors which may be quite appreciable when measuring very thin materials and this factor has to be catered for, either by automatically correcting the calibration at frequent intervals, or by introducing a flow of temperature-controlled air into the measuring head. In automatic-control installations it is often desirable to adopt both of these measures.

The output signal of the instrument can be displayed in two forms, either as an indication of actual thickness or as a deviation from a desired thickness set on a calibrated reference potentiometer. The latter is used in automatic-control applications where the deviation-signal voltage is used either to energise a proportional controller to correct the process or, as in the case of steel-sheet sorting, to operate discriminators which classify the product into various thickness grades.

The measurement of coatings such as lacquer on steel or plastic on foil can be carried out using either the backscatter or differential transmission method.

The backscatter method involves a measurement from one side of the sheet only and relies on the radiation scattered backwards from the basic metal sheet being attenuated by the coating being applied. In this case it is essential that the coating should be of very different mean atomic number from the base material. Also, the radiation from the source being used should not be so energetic as completely to penetrate the base sheet, otherwise thickness variations of the base sheet will influence the readings obtained. The differential system does not suffer from these disadvantages and utilises two transmission measuring heads as previously described, connected in such a manner that the output currents of the two chambers are in opposition. Since one measuring head measures the uncoated material and the second measures the coated material, the

out-of-balance current is related to the actual weight of the coating being applied.

By applying the output deviation signals of the gauges described to control the appropriate process variable, such as the nip setting of a plastics calender or rolling mill, the product can be kept within very close tolerances well inside the usually required limits, with obvious resultant savings in cost and improvement in uniformity and reliability of the finished components.

Measurement of Surface Resistivity

For about forty years no significant changes have been made in the methods accepted for the determination of the surface resistivity of dielectric materials. Recent work has shown that the results given by these methods may not be accurate ; inherent errors in measurements of surface resistivity arise from the shunt resistance through the bulk of the material and from the resistance of the electrode-surface-film interface. The sources of these errors were examined and methods of reducing them were suggested in a paper by E. C. Salthouse and D. S. McIlhagger.

This paper included a description of a parallel electrode system (Fig. 2) devised and

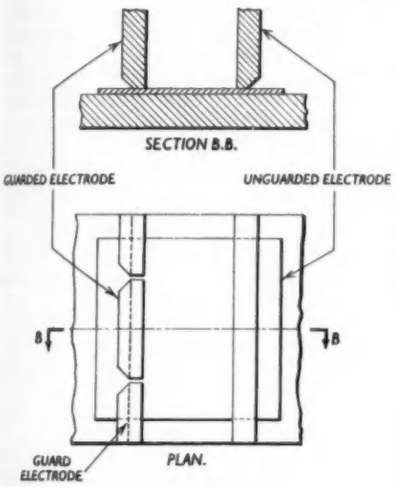


Fig. 2—Electrode system

built by the authors, to measure surface resistivity only, avoiding the errors mentioned above. The electrode system was made as large as possible without causing undue distortion of the applied voltage gradient A parallel electrode geometry was chosen in preference to the circular system, since the latter gives rise to unequal current densities at the two electrodes, especially for large values of l (the distance between the measuring electrodes). Further, with the circular system the voltage distribution between electrodes cannot be measured easily, nor can the electrode separation be readily altered. To avoid fringing effects at the ends of the two parallel electrodes one was split into three as shown in Fig. 2. The two outer portions, together with the third electrode on the under-surface of the specimen, comprise the guard electrode. This arrangement eliminates any direct surface leakage path between the two measuring electrodes.

Insulation Serviceability of Turbo-Generator Stators

Methods of assessing the insulation serviceability of turbo-generator stators and of high-voltage bushings were discussed by K. H. Stark. In general the author's findings were that it is not practical from existing tests and knowledge of electrical insulation to predict the long-term behaviour of insulation from short-time tests. The best that can be hoped for in the near future is an improvement in the methods of checking the manufactured article and of assessing when, through use, the article has reached an unsafe condition.

The author's work on this subject resolved itself into : first, checking the claims of previous investigators, particularly exponents of the high-voltage d.c. test ; and, secondly, establishing whether, with the apparatus now available, other and better methods are possible. The work on machines was restricted to finding a method which indicated if a turbo-generator stator had aged prematurely. Several machines of various ages, which had been in normal service were tested in the hope that any changes discovered could be correlated with the age of the machines. These machines included twelve turbo-generators ranging from 6 to 125MVA rating, at voltages of 6·6, 11 and 13·8kV, and from new to twenty-six years old. All the machines were subjected to the following tests: (a.c.) loss and discharge characteristics of stators ; (d.c.) dispersion factor, polarisation index and absorption current, high-voltage resistance of stators.

Conclusions.—The author found that, of the methods tried, the discharge detector proved the most informative as a non-destructive test of changes in insulation with age in normal service. He concluded that the onset of preferential deterioration at the line terminals relative to the neutral terminals, caused by discharge erosion, can be detected by an E.R.A. model II discharge detector after about fifteen years normal service for a stator insulated with shellac-bonded mica. As stators of the kind tested perform satisfactorily in service for more than thirty years, the discharge erosion is not severe enough to cause trouble. The work described merely provides evidence of its existence. The deterioration of the insulation also reduced the onset voltage of large discharges.

Unfortunately, the correlation between the discharge characteristics and the stator age is too variable for the discharge test to be used as the sole guide to the insulation condition. The same criticism applies to the 50 c/s and 1 kc/s loss angle, the desorption current and the d.c. resistance. The scatter between the individual measurements and the age of a turbo-generator stator that has undergone normal usage is reduced considerably if all the measurements are considered. This leads to a smooth relation between the dielectric properties and the age of turbo-generator stators insulated with shellac-bonded mica. Deviations from this relationship indicate those machines that have aged excessively.

Cables

Methods used for the location of leaks in buried pressure cable systems were described briefly by H. T. Gooding and T. A. Briant. The early methods of location include the use of amyl mercaptan, the oxygen sandwich and the use of heat flow coils. The more modern tests include fall-of-pressure and direction-of-flow tests and the use of halogen tracer gas.

Experimental work on the use of radio-active isotopes in this context was briefly referred to by the author. The method of application is similar to that for halogen tracer gas and field trials with prototype equipment have shown great promise. As there is considerable saving in the size of the detection equipment it is hoped that this method will soon have reached the stage of offering a useful alternative to the halogen detector or, possibly, a substitute for it.

The use of discharge tests applied continuously to monitor the serviceability of the extruded insulating coverings of cables was discussed in a paper by R. C. Mildner. He referred to continuous discharge detectors based on (*a*) measurement of the transient electrical disturbance to the system caused by the discharge or on (*b*) measurement of the electromagnetic or sound pressure waves emenating from the discharge. Practical forms of the method based on electrical observations were discussed in greater detail with particular reference to the system used by the company with which the author was formerly associated. He referred to some of the limitations in the usefulness of the present form of testing and offered suggestions for the further development of the method.

For example one possible scheme for providing freedom from interference, with other advantages, is shown in Fig. 3. It requires the use of a split high-voltage electrode E_1E_2, each half being fed with power-frequency high voltage through band rejection filters F_1F_2, tuned to the frequency of the detector. The two half-electrodes are connected to a differential transformer, T_1, the secondary winding of which is connected through high-voltage blocking capacitors, C_1, C_2, to the detector. Signals would pass to the detector whenever discharges were present in one half-electrode.

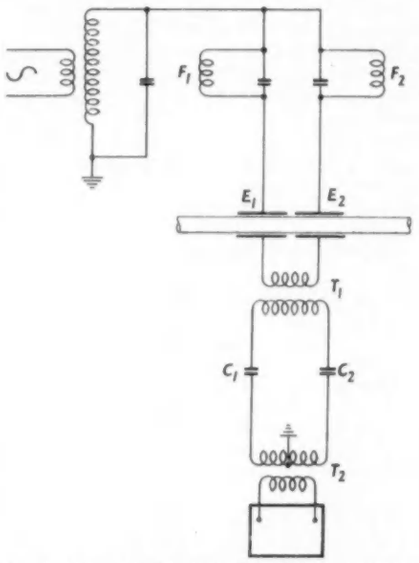


Fig. 3—Schematic of proposed modified continuous discharge detector

The scheme outlined could not only overcome the problem of external interference, but would avoid the trouble due to the variable-impedance high-frequency circuit through the cable. It also offers the possibility of applying two high-voltage tests simultaneously on the same core : one test might be designed to ensure that the cable was free from discharge at the operating voltage, whilst the second might be conducted at a higher voltage to assure good performance against over-voltages. Understanding of the breakdown mechanism is not yet sufficiently advanced to state with any certainty precisely what discharge criterion should be used for this purpose. There is no doubt, however, that a suitable criterion will eventually emerge.

(To be concluded).

THE ENGINEER

REVIEW OF BOOKS

NOVEMBER, 1961

TRANSPORT PHENOMENA

R. B. BIRD, W. E. STEWART, and E. N. LIGHTFOOT

Publishers: John Wiley and Sons, Inc. 1960. *Price* 110*s.*

SINGLE aspects of *Transport Processes* have been dealt with in several monographs recently published. R. C. L. Bosworth (1956) has expounded the related problems with special reference to "The Flow of Physical Properties in Chemical Reactors." *Momentum Transfer in Fluids* (1956) by W. H. Corcoran, J. B. Opfell, and B. H. Sage, Chemical Engineering Laboratory, Caltech, presents a comprehensive account on laminar and turbulent shear-flow, boundary layer analysis, and statistical treatment of turbulence. An advanced, highly mathematical chapter on "Transport Processes" (100 pages) is given in a book by J. O. Hinze on *Turbulence: An Introduction to its Mechanism and Theory*. In contrast *Transport Phenomena* opens a wider approach to the three subjects of flow, heat and mass transfer. The authors rightly state that a book of this kind is warranted "because of the current demand in engineering education to put more emphasis on understanding basic physical principles than on the blind use of empiricism." They claim that the subject matter is sufficiently basic and that the subject of transport phenomena should rank along with thermodynamics, mechanics, and electromagnetism as one of the key "engineering sciences."

The importance and the didactic value of the book under review lies in the extensive use of analogues as tools of analysis. The chapters of the book are arranged to give a vertical and a horizontal organisation of the subject matter. The three main parts, momentum, heat and mass transfer, form the vertical columns while horizontally arranged subjects, such as transport by molecular motion, transport in laminar flow, transport in an arbitrary continuum, transport in turbulent flow, interphase transport, and transport in large flow systems are dealt with under each of the main headings. Part of the scheme is given in the Table.

Analogy plays an important part in scientific development. Correlating laws of nature and interpreting them with the same type of differential equation is one way of expressing analogy between different phenomena of flow, heat, and diffusion. The other way of establishing an analogy, which also leads to the model laws of dynamic similarity, is the transformation of the basic differential equations, "the equations of change," and obtaining certain non-dimensional terms such as the Reynolds number and the Froude number as invariants. In the first case a solution of one problem related to a specific phenomenon may be readily extended to another phenomenon. In the second case the analogy is concerned with a more specific "similarity" as it is related to one and the same phenomenon under changed conditions with respect to the components of the non-dimensional terms, e.g. the Reynolds numbers or Froude numbers or other non-dimensional entities.

The introductory chapters to each of the three main subjects emphasise the analogy concept between Newton's Law of Viscosity, Fourier's Law of Heat Conduction, and Fick's Law of Diffusion. Furthermore, analogy exists within each subject, flow, heat, and diffusion. This similarity is specified by equal numerical values of certain non-dimensional terms such as the Reynolds, Froude, Péclet, and Mach numbers. A limited analogy exists in the three subjects under some restricting conditions with respect to Chilton-Colburn coefficients of heat and mass transfer and the friction coefficient (page 647). But the authors are very careful not to stress analogy too far, for instance in the last mentioned example. The critical assessment of the meaning of analogy is one of the merits of the book. However, some confusion may result from the "Brinkman number" which the authors use in connection with problems of "viscous heating." The authors relate the Brinkman number to such diverse applications as flow of plastics through dies in high-speed extrusion, and flow of air in the boundary layer of an earth satellite or rocket during re-entering the earth atmosphere. In a footnote (page 339) it is stated that the ratio of the Brinkman number and the Prandtl number is equal to the Eckert number, which in turn is proportional to the Mach number (page 346). From the foregoing it is evident that viscosity is an essential component of the Brinkman number, but, it is neither included in the Eckert number nor in the

TABLE—*Scheme showing the organisation of some of the* 22 *chapters*

Type of transport \ Entity being transported	Momentum	Energy	Mass
Transport by molecular motion	Chapter 1 "Viscosity and the Mechanism of Momentum Transport." (Newton's Law. Temperature, pressure and composition dependence of viscosity. Kinetic theory.)	Chapter 8 "Thermal Conductivity and the Mechanism of Energy Transport." (Fourier's Law. Temperature, pressure and composition dependence of thermal conductivity. Kinetic theory.)	Chapter 16 "Diffusivity and the Mechanism of Mass Transport." (Fick's Law. Temperature, pressure and composition dependence of diffusivity Kinetic theory.)
Transport in laminar flow or in solids, in one dimension	Chapter 2 "Velocity Distributions in Laminar Flow." (Velocity profiles. Average velocity. Momentum flux at surfaces.)	Chapter 9 "Temperature Distributions in Solids and in Laminar Flow." (Temperature profiles. Average temperature. Energy flux at surfaces.)	Chapter 17 "Concentration Distributions in Solids and in Laminar Flow." (Concentration profiles. Average concentration. Mass flux at surfaces.)
Transport in an arbitrary continuum	Chapter 3 "The Equations of Change for Isothermal Systems." (Equation of continuity. Equation of motion. Equation of energy.)	Chapter 10 "The Equations of Change for Non-isothermal Systems." (Equation of continuity. Equation of motion for forced and free convection. Equation of energy.)	Chapter 18 "The Equations of Change for Multicomponent Systems." (Equations of continuity for each species. Equation of motion for forced and free convection. Equation of energy.)
Transport in laminar flow or in solids, with two independent variables	Chapter 4 "Velocity Distributions with more than one Independent Variable." (Unsteady viscous flow. Two-dimensional viscous flow. Ideal two-dimensional flow. Boundary-layer momentum transport.)	Chapter 11 "Temperature Distributions with more than one Independent Variable." (Unsteady heat conduction. Heat conduction in viscous flow. Two-dimensional heat conduction in solids. Boundary-layer energy transport.)	Chapter 19 "Concentration Distributions with more than one Independent Variable." (Unsteady diffusion. Diffusion in viscous flow. Two-dimensional diffusion in solids. Boundary-layer mass transport.)

Mach number. Dimensional equality can be obtained between all non-dimensional terms by definition but to replace one number by another is a procedure which cannot be recommended, as in most cases it becomes meaningless. Therefore, the question arises, whether two distinct and separate non-dimensional terms should be used to characterise the problems.

The authors are primarily concerned with establishing basic relations of the three transport phenomena by means of analogy starting from first principles. They also apply dimensional analysis in establishing all the pertinent non-dimensional terms of fluid flow, heat transfer, and diffusion. But, beyond a few examples, they do not present a comprehensive survey of experimental results on the basis of non-dimensional terms. As the first mentioned way of approach, having basic relations, is essential for a more rational application of non-dimensional terms in the interpretation of experimental results, the book serves a very useful purpose counteracting " the blind use of empiricism."

The book is very well illustrated by numerous examples, questions for discussion and problems. There is a problem which the authors could have included, namely, two-phase flow, which is only mentioned in a footnote on page 54. The problem of adjacent flow of two immiscible fluids is restricted to a layer of small thickness with prevailing viscous flow conditions. A more general discussion of this problem could have led to the interesting phenomenon of the hydraulic jump in two layer flow. To all students who are interested in an exhaustive treatise on the application of analogy as a tool of engineering analysis the book is highly commendable.

[Reply Card No. 1259]

ATLANTIC ERA

The British Atlantic Locomotive.

MARTIN EVANS

Publishers : Percival Marshall and Co. Ltd. 1961. *Price* 12*s.* 6*d.*

UNIFORM with his previous volume, *Pacific Steam*, the author in the present book presents a review of the development of locomotives built for passenger services on British railways, having the 4–4–2 wheel classification, which are described as being of the " Atlantic " type.

In the Preface the name " Atlantic " is said to be derived from the fact that locomotives having this particular wheel classification were at one time largely and successfully used for fast passenger services on the Atlantic City railway, working express trains between Camden and Atlantic City. But in fact whether what the author calls the nickname " Atlantic " was so derived is open to question. According to Paul T. Warner, of the Baldwin Locomotive Works, writing in *Baldwin Locomotives* of October, 1924, the " Atlantic " (4–4–2) type was developed by the Baldwin Locomotive Works in 1894 to meet difficult operating conditions on the Atlantic Coast Line and this locomotive was the first ever built having this particular wheel arrangement, embodying a leading four-wheel bogie, followed by four coupled wheels and having a pair of trailing wheels to support the firebox. It has usually been assumed, not apparently without justification, that the name " Atlantic " was derived from the fact that these particular locomotives were first built for the Atlantic Coast Line. These Baldwin locomotives, characterised by having the wheel arrangement described, had two cylinders outside, the drive being taken by the trailing pair of coupled wheels ; this, together with the particular wheel formation, has, we think, been generally taken as being the characteristic of the true " Atlantic." Such being the case there may be an element of doubt as to whether other locomotives having this particular wheel arrangement but with cylinders arranged differently may, strictly speaking, be called " Atlantics." However, whether or not the title given to this new book is strictly correct in no way detracts from its value as giving a concise record of the development of express locomotives of the 4–4–2 type on British railways.

As was the case in his former volume, *Pacific Steam*, reviewed earlier this year in our issue of June 16, the author has presented a detailed account of the development of British locomotives of what are described under the general heading of the " Atlantic " type, taking the various designs in the order of their appearance.

The book commences, therefore, with those built at Doncaster by H. A. Ivatt, who turned out his first " Atlantic " in 1898, just four years after the initial design built at the Baldwin Locomotive Works, Philadelphia. When Ivatt built his first 4–4–2 type locomotive, No. 990, he undoubtedly inaugurated a new era in the design and construction of high-speed locomotives for British lines and, moreover, it is an interesting commentary on the fact that the appearance of engine No. 990 proved, as events subsequently showed, to be the middle link in the progressive evolution of express locomotives designed on one basic plan. In other words, commencing with Patrick Stirling's " single-driver " locomotives, having outside cylinders and 4–2–2 wheel formation ; the " Atlantics " followed, also having outside cylinders but with 4–4–2 wheel plan ; and then, later came the Gresley " Pacifics " of 1922, having the 4–6–2 wheel arrangement. Further, had it not been for the untimely passing of Sir Nigel Gresley in 1941 this progressive increase in the size of locomotives, the designs of which were all founded on one basic plan, would have been extended to a further design having the 4–8–2 wheel classification ; thus presenting what might perhaps be called a perfect and logical development in motive power for handling fast passenger services.

The author properly gives considerable attention to the Great Northern " Atlantics," designed by Ivatt, which, in association with four-coupled locomotives having the same wheel arrangement on the North Eastern railway, from about 1902 up to the coming of the first Gresley " Pacifics " in 1922, successfully handled the important East Coast express services.

In discussing the performance of Ivatt's " large " " Atlantics," first built in 1902, mention is made of comparative trials carried out on the London North Western and Great Northern railways in 1910 between Ivatt's " large " " Atlantics " with the wide firebox and the London North Western 4–4–0 type locomotives of the " Precursor " class, to which some reference was made in THE ENGINEER of August 12, 1960. In connection with these trials it may perhaps be of interest to recall some particulars of the performance of the Ivatt " large Atlantics " by their designer when contributing to the discussion of a paper on compound locomotives in France, by M. Edouard Sauvage, Chief Consulting Engineer, Western Railway, France, Institution of Mechanical Engineers. Ivatt's contribution to the discussion will be found in our issue of April 22, 1904, where particulars of some experiments carried out with the first of Ivatt's wide firebox " Atlantic," No. 251, will be found on page 408. From this it appears that the highest indicated horsepower was obtained when the engine was travelling at 75 m.p.h. on a falling grade of 1 in 264, when the engine developed 1192 i.h.p.; the regulator is stated to have been fully open and the indicator diagram showed a mean pressure of 57·7 lb per square inch.

Turning to our issue of April 15, of the same year, comprehensive particulars will be found of a trial made with one of the North Western 4–4–0 type locomotives, No. 513 (" Precursor ") : the particulars again give the powers developed in the cylinders at various speeds on two test runs between Crewe and Rugby and return, and it is of interest to note that the " Precursor " locomotive maintained an average cylinder power of just over 1032 i.h.p. at 57 m.p.h. and that the maximum power developed was as much as 1197 i.h.p. when running on a level road at 52 m.p.h. In considering these results it would of course be borne in mind that the tractive effort developed by the " Precursor " per lb of mean effective pressure was somewhat higher than that in the case of Ivatt's " Atlantic," which had smaller cylinders, 18½in diameter by 24in stroke, compared with the 19in diameter by 26in stroke for the North Western engine. The diameter of the driving wheels was respectively 6ft. 7½in and 6ft 9in.

It is perhaps an open secret that while the Ivatt " Atlantics " unquestionably did excellent work from their inception, they were nevertheless greatly improved when fitted with superheaters and larger cylinders. Records of their attainments in later years, when modified in the manner mentioned, give added interest to the author's chapter dealing with these famous locomotives.

Following the reference made to the Great Northern locomotives, Chapter 2 deals shortly with Aspinall's 4–4–2 type locomotives built for the Lancashire and Yorkshire railway during the early years of the present century, and here it may be mentioned that the author in his Preface excuses himself for including these engines, they have two inside cylinders. In view of the fact that a large number of engines subsequently dealt with are the multi-cylinder type with both inside and outside cylinders, there seems no reason for offering any excuse for including the Aspinall locomotives.

North Eastern engines introduced by Wilson Worsdell and later those built from the designs of Sir Vincent Raven receive adequate attention. One especially interesting illustration shows one of the Raven three-cylinder engines as fitted with Stumf " Uniflow " cylinders.

Throughout the book, the author adds much to the interest of his work by giving particulars of the performance of the various 4–4–2 type locomotives which he describes in greater or less detail. In particular, much attention is given to the four-cylinder compound locomotives imported at the instigation of G. J. Churchward for experimental

REVIEW OF BOOKS *(Continued)*

use on the Great Western railway. In fact, the chapter on Great Western "Atlantics" appears to be mainly given up to a description and performance of the French locomotives, while Churchward's two-cylinder simple expansion locomotives of the "Atlantic" type receive but scant attention.

Following the remarks made concerning Churchward's locomotives, the next chapter is devoted to the 4-4-2 type "Atlantic" locomotives built fror the Great Central railway from J. G. Robinson's designs.

In discussing the North British "Atlantics" a reference is made to the comparative trials carried out with these locomotives and others, which appear to have indicated that the North British engines required when first built a somewhat heavy coal consumption for the work done; however, it is interesting to note that after superheating their performance in this respect was considerably improved.

In a final chapter, that dealing with the Marsh "Atlantics" on the London, Brighton and South Coast Railway, we again find a very complete and concise review of these locomotives, together with some particulars of their performance, which, as already indicated, adds much to the value of the book.

It may be said in conclusion that the author has succeeded in finding a large number of interesting photographs of the various engines and for the most part these are well reproduced. As was the case with *Pacific Steam*, the production by the publishers leaves nothing to be desired.

[Reply Card No. 1329]

EVAPORATIVE COOLING OF CIRCULATING WATER

L.D. BERMAN

(Translated from the Russian by R. Hardbottle)

Publishers: Pergamon Press, Headington Hill Hall, Oxford. 1961. *Price* 140*s.*

As England was the first country to be industrialised and its industry grew unplanned in relation to the few sizeable rivers, it was naturally the first country to have to make extensive use of artificial cooling of circulating water. Starting with plain cooling ponds for small industry 100 years ago, practice has evolved by rule of thumb through spray ponds and "atmospheric" coolers to wooden cooling towers, and finally to large concrete towers for power stations. At various stages ideas from Germany and Holland have been incorporated but improved and adapted, until the natural draught cooling tower has attained in Great Britain its highest development anywhere in the world. This evolution took place largely without guidance from theory, the process having been one of gradual stepping up of sizes based on experience of previous designs modified by hunch and cut-and-try. The technique had reached almost its present status when the first adequate theoretical analysis of natural draught towers appeared in English in 1950. This was followed by a number of papers offering semi-empirical design criteria, with the result that for some years there has been available for those who have the time and the ability to use elementary mathematics a practical working theory, together with various short cuts providing reasonably accurate design data.

The foundation of this theoretical structure is the work of Merkel in Germany (1925) modified and developed in the U.S.A. by various authors in the 1930's in connection with mechanical draught towers. Merkel's concept, which has proved the clue to manageable methods of calculation, is that the rate of heat transfer is to be regarded as proportional to the difference of total heats (enthalpy) of the saturated boundary layer of air at the temperature of the hot water and that in the main body of the air. Once the universal applicability of this idea to all evaporative cooling was appreciated there was no mystery in tower, lake or even river cooling in tidal waters.

In view of this background it seems curious that Pergamon Press has thought it worth considerable trouble and expense to produce by photography a translation of the second edition (1956) of a Russian monograph by L. D. Berman, of which the first edition (Russian) appeared in 1949. Information from Russia would have to be in urgent demand to justify poor reproduction and diagrams, the use of continental units, cumbrous treatment of the subject and many obsolete looking illustrations. If it were supposed that because of the Russian predominance in rocketry any publication on a technical subject would be of outstanding interest this book should provide a corrective. It contains so far as can be traced nothing indigenous to Russia, most of the designs being recognisable as derived from other countries. Some of the drawings would suggest that they were obtained from Germany as far back as the Kaiser's time and not much advance has been made since. Moreover any theoretical progress has apparently made no more impression on practice in Russia than it has here.

The book contains nearly 400 pages in quarto format 11in by 8⅝in and is 1in thick. It is reproduced photographically from typescript and though the symbols used include the Greek alphabet and thus cover a wider selection than appears on a normal typewriter, the absence of letterpress does impose severe restrictions on choice of font and makes the indications of page numbers, equation numbers, and section numbers somewhat difficult to sort out. Many of the diagrams suffer in reproduction and some are much too small to decipher.

The text is divided into two parts, Part 1 on theoretical principles, Part 2 on practical designs. The first chapter of fifty-nine pages deals exhaustively with wet bulb hygrometry, which is the foundation of any study of evaporative cooling. It does not appear that this contains any method or information not already familiar in western countries though many well-known concepts are attributed to Russians, e.g. the Mollier chart to Ramsin. The illustration of "August's hygrometer," merely the familiar unventilated wet and dry bulb, which could have been taken from an English book on natural philosophy in 1840, offers mute comment on the state of development of the subject in the U.S.S.R.

The second chapter deals with the cooling of open water, sprays, cross and counter-flow cooling, leading up to the "total heat" method in general terms. It gives no practical figures, for which we have to look in later chapters. Chapter 3 deals with such issues as flow lines in a pond, the qualities of sprays produced by nozzles, and the resistance of certain forms of fill, including data collected by the author and his colleagues as well as information culled from American literature and some information on air distribution derived from model research. The probability that the models do not reproduce the conditions in actuality does not appear to have been considered: for instance no one with practical experience of cooling towers will find it easy to believe that the entering air squeezes the flow into a vena contracta and causes back flow in any practical design of tower worthy of the name.

Chapter 4, being the first chapter in Part 2, deals with practical designs of plain ponds, spray ponds, atmospheric coolers and cooling towers of various inelegant wooden types but including one illustration of a Mouchel design, also the large cylindrical concrete tower at Goldenberg, various mechanical draught types from U.S.A. catalogues, and the mixed natural- and induced-draught hyperbolic form of Blacke. Details such as types of spray heads and of laths and quantities of materials required are quoted, but no performance figures—they are contained in the next chapter on thermal design of coolers where, however, the data is not specifically related to the designs illustrated earlier.

Finally the sixth chapter deals with operation of coolers, testing, maintenance, and design to avoid icing up in winter where Russian experience is of special value. There is discussion of vegetable growth in coolers and water treatment, but no comment on fungal attack on the timber which one would think to be an important issue.

Appendices contain tables of properties of water, dry air, and saturated vapour, and charts show the enthalpy and density of humid air. A psychrometric chart in temperature-mass ratio co-ordinates ($t-x$) is included though the alternative and more convenient temperature-enthalpy ($t-h$) diagram is used for exposition in the text. The bibliography contains some twenty books and over 100 papers in Russian with somewhat less than twenty non-Russian papers added at the end, out of alphabetical order.

The book is difficult to use, partly because of the separation of the description of the equipment from its performance and partly because of curious wording and the difficulty in getting used to methods and symbols (though the editor has evidently made a commendable effort to adopt symbols which are generally accepted in English, they are

not all explained in the list). One is left with the impression that the data have been collected as an academic exercise and neither data nor the methods described are put to any practical daily use such as would have refined them into clear-cut procedures. Some of the views e.g. that low barometer or high wind is deleterious to performance are neither in accord with theory nor observation. The concept of logarithmic mean is used where the mathematics really requires the harmonic mean which is simpler in use.

Redrawing in terms of "approach" would improve many of the curves and if these were not drawn to a suppressed zero the implications of the form would be more readily appreciated. For those interested in the details of various types of fill and alternative forms of shell (many now obsolete) the book will arouse some interest, but it does not appear to provide any guidance on the important issue of how to translate data obtained on elements of a fill into full scale behaviour in the actual tower.

Awkwardness in translation creates confusion, e.g. "hyperbolic" is used to denote a type of fill, namely that used by Mouchel, while "stack" which in England is frequently used (unfortunately) to mean the fill, here means the chimney. "Shuttering" seems to mean louvres, "packing" and "filling" are apparently used interchangeably according to the source of the data, "drop cooler" is apparently a cooling tower and there are apparently also "driving force tower coolers" (unexplained).

[Reply Card No. 1383]

AIR-COOLED MOTOR ENGINES

JULIUS MACKERLE, M.E.

Translated by K. Caslavsky and H. Snabl. Edited by E. H. Maclachlan.

Publisher: S.N.T.L.—Publishers of Technical Literature—and Cleaver-Hume Press Ltd., 31, Wright's Lane, London, W.8. Price 55s.

As the tautology of the title suggests, this is a translation, the author being head of the engine department at the Research Institute for Motor Vehicles in Prague; there have also been published two Czech editions and versions in Polish and Russian. This edition was in fact printed in Czechoslovakia, so that the accuracy and clarity of the compilation should not pass without praise—but such is indeed likely to happen, for the English-speaking engine-eer may well to be enthralled by the thinking with which the pages are infused. The subject is in fact directly-cooled piston engines, but since the consequential virtues of direct cooling—high efficiency, light weight, insensitivity to environment, long servicing intervals, and tolerance of abuse—are in demand particularly in the field of transportation, the author concentrates his attention on engines able to meet the severe requirements of this employment. The explanation of why the air-cooled engine can satisfy more exacting demands than the indirectly cooled equivalent is made in the first part of the volume, that devoted to Theory, and hence the discussion is rather less than complete, such practical but effective limitations as cavitation erosion on the water side of cylinder walls being ignored—there are, in fact, indications that the author is less familiar with indirect than direct cooling, since he advocates applying the latter to the lubricant in all cases, whereas the users of indirectly-cooled and throttle-controlled engines complain that when the water is cold the oil is too hot, and *vice versa*. The author does, of course, seek verification of his expectations, but quantitative data about any, let alone comparable, engines are hard to find, and comparisons are in fact made only in respect of specific power and power-weight ratio, of which the latter at least is important in the field of transportation. It should not be thought that the author proposes air cooling for air cooling's sake; the even more direct form of cooling, internal cooling, is given a brief but sympathetic discussion, particularly in the context of suppressing detonation at full load without the use of uneconomically high quality fuel. The detailed theory starts with a treatment of heat transfer in general and from solid to gas in particular, and then proceeds, logically enough, to discuss heat transfer from charge to combustion chamber boundaries, conduction through the engine, the finned surface, and then the behaviour and necessary volume of cooling air. The last two chapters in this first part illustrate sharply the author's unquestioning assumption that an air-cooled engine will be designed for high performance; he demands control of coolant flow, and will allow the fan to work in the heated fluid only if there are exacting demands for even distribution between cylinders or a need to direct air from more than one direction on each cylinder; and he begrudges the exhaust its more-than-fair share of the heat input, pointing out how admirably suited is this stream of energy to propel the coolant flow, either by the agency of a turbine and fan—the neglect of this potentiality he blames on the cost of the "equipment," presumably the speed reducer between turbine and fan—or by means of an ejector, a technique much used on aircraft and applied to a Tatra 603 V-8 intended for a racing car.

By the time he reaches part two, Design, any insular English reader will probably be wondering why the air-cooled engines of his acquaintance dominate the water-cooled engines neither in numbers nor in performance, so much so that one even finds ground effect machines being built with radiators in this country. Mr. Mackerle leaves him in doubt but shortly, making it clear that the directly cooled engine is one of those exacting design exercises in which a number of largely unrelated effects and some which are highly inter-dependent—internal and external aerodynamics, heat transfer, distribution of stress and temperature, dimensional stability, vibration, acoustic radiation, foundry and forge difficulties, and of course economics—have to be considered and satisfied simultaneously. By this stage, one does not expect any problems to be shirked, and nor are they; it is admitted that with side valves it is stringently difficult to cool the exhaust valve seat uniformly, and that with an overhead camshaft spanning more than two cylinders it is necessary to consider the case of one cylinder misfiring and remaining relatively cold, and thus the author is confronted with the savage difficulty of reconciling push-rod valve gear with an ambitious design performance. The result is a chapter shorter only than that devoted to the cylinder head, and even then it is not comprehensive, although sleeve valves (which are, not surprisingly, discounted in view of the barrier to heat transfer posed by two oil films, though it might be complained that the comparison of port areas achieved should have included a poppet-valve diesel) and rotary valves are considered. Since the author has also published a volume devoted solely to valve gear, it is perhaps unseemly to point out that he has ignored desmodromic operation, although it is on the air-cooled engine that there is most difficulty in dissipating the hysteresis losses in springs, and that since the cooling with oil of pistons is discussed so also should be that of valves—we say "perhaps" since we have not consulted the reference, which is in Czech.

The cooling fan is awarded a chapter to itself, in which, because of the fundamental appeal of running the fan in the cold air, emphasis is laid on the need to avoid running stalled. A short account of crank design and lubrication problems is given; in view of the susceptibility of an air-cooled cylinder to overheating due, for instance, to petrol starvation or fin blockage, it is surprising that no reference is made to the possibility of "fail safe" lubrication with, say, a molybdenum disulphide dispersion. The discussion of engine starting brings out a secondary advantage of direct cooling; if the engine is fitted in a vehicle which has a self contained air heater, the latter can be used to pre-heat the engine. A warning is given against mounting a simple mechanical petrol pump directly on the engine.

The two-stroke cycle, which tends to raise intense cooling problems because it is adopted where high specific output is required, is given a chapter to itself, and the author does not scruple to admit that in the case of piston-ported engines direct cooling sets a limit to the output per cylinder. A particularly valuable feature of this chapter is a discussion of the "Orion" power plant for fighting vehicles in which both the exhaust and coolant of a six-cylinder opposed piston two-stroke were delivered to a turbine; the important question of whether the design would have worked in practice is not essayed.

The final one-eighth of the text is devoted to descriptions of designs of directly-cooled engines. The examples chosen include some of great interest, such as the Chevrolet "Corvair" and the ambitious Continental range, which are claimed to be able to start at 0 deg. Fah. when running in carburretted form on wide cut JP-4. The English examples may, however, not be considered well chosen; the Sunbeam S-7 is important as an example of a design with cylinders and crankcase cast together—despite his advocacy of plated aluminium cylinders, the author takes little interest in "monobloc" designs—as well as for its quietness and flexibility, but one misses any mention of the Ariel "Square Four," an even more ambitious departure from the commonplace construction with numbers of identical cylinders bolted in place, and so rare are comparable air- and water-cooled engines that it would surely have been worth while to have included the horizontally opposed Velocette twins, the water-cooled side-valve LE, the air-cooled o.h.v. "Valiant" and the synchronous two-stroke "Viceroy." It is tantalising also to realise that the leader of a Research Institute in a far-away country would be particularly well qualified to discuss why every attempt in this country to advance the status of air-cooled engines—the Bristol radials with Burt-McCollum sleeves, the S-7 and the "Square Four," the three-cylinder "Talisman" and the parallel twin

REVIEW OF BOOKS *(Continued)*

Velocette—adds but a longer or shorter chapter to a dispiriting saga of unsuccess.

Here it is, in fact, that one comes to the one substantial and general complaint against this volume. For those with a specialist interest and knowledge of the subject, it is quite excellent, and occasional quirks such as "turbulent" for "eddy current" are insignificant. But in the English language there is much need for a better appreciation of direct cooling by many other than engine designers and motor cyclists, and those with merely a general interest may well be put off by the occasional infelicity of the text and the curt, unexplained statements of fact (e.g. "In horizontal engines a separate jet of oil must be directed against the upper cylinder region of the right-hand bank of cylinders."). It might well be that the English-speaking countries would both buy and benefit from a new edition in which Messrs. Mackerle and Maclachlan could develop to the full the past, the present and the potential of the directly cooled piston engine.

[Reply Card No. 1282]

ESSENTIALS OF DIELECTROMAGNETIC ENGINEERING

H. M. Schlicke.

Publisher : John Wiley and Sons

Price 76*s.*

THE view has recently been expressed that progress in electronic engineering depends to a great extent on the development of new materials. However, materials with unusual properties not only bring the possibility of novel devices but may also set unexpected problems when used in more or less conventional applications.

This book sets out in five chapters to illustrate the recent developments in high permeability magnetic and high permittivity dielectric ceramics used in electronic components. Chapter 1 discusses theoretically the behaviour of ideal materials first at low frequency and subsequently at high frequencies. In particular, it is shown that dimensional resonances which normally exist only at microwave frequencies can occur in the v.h.f. range and lower, due to reduction in the velocity of propagation of electromagnetic waves in these new ceramics. In Chapter 2 some of the physical properties of real materials are discussed. The value of this chapter is somewhat reduced by the fact that the properties relate to materials available only in the U.S.A. Chapter 3 deals with low frequency applications, concentrating on the behaviour of ferrite inductors as a function of power level and d.c. bias. The high-frequency applications which require the consideration of the component as a distributed parameter circuit are covered in Chapter 4. The author here introduces a very useful summary of matrix algebra techniques applied to four-terminal networks and employs these techniques in the study of resonance phenomena in high-permittivity feed-through capacitors, a field in which the author is an acknowledged expert. The final chapter covers briefly non-linear and non-reciprocal behaviour in ferrites. Parametric amplification is dealt with in some detail although the successful applications of this principle have mainly employed semiconductor devices and not ferrites, while non-reciprocal microwave properties which can only be realised in ferrites are given rather inadequate coverage. The subjects of magnetic amplifiers and the use of magnetic cores for switching and storage in digit computers are not discussed at all.

In a work of this length it is necessary to restrict the range of subjects covered ; it is open to question whether Dr. Schlicke has found a reasonable compromise in his selection. The book contains no more than the customary number of errors, but the English reader may find the author's style a trifle strange in places. This book appears to be of value mainly to the specialist electronic engineer who wants to keep up to date with modern components.

[Reply Card No. 1384]

PLASTIC AND ELASTIC DESIGN OF SLABS AND PLATES

R. H. Wood

Publishers : Thames and Hudson, Ltd.

Price 63*s.*

THIS book by Dr. Wood of the Building Research Station is probably one of the most important books on engineering which has appeared in English in recent years. Part of this importance, but by no means a large part, is due to the non-translation into English of Johansen's work on yield-line theory. The book is essentially a treatise on the design of reinforced concrete slabs, although one chapter is devoted to steel plates, and takes into account the steadily increasing volume of research work done on this subject. It is perhaps a little ironic that it was the advent of the atomic bomb that gave rise to a spate of work in this country on the real strength of concrete slabs, but, be that as it may, the work that has been done, largely on the analytical side by Dr. Wood, has enabled him to present what must appear to many engineers as a "break through" in engineering knowledge. Johansen's contribution to flat slab design was the yield-line theory based on plastic yielding along a definite line but this did not explain the extraordinarily high loads that flat slabs can carry under certain circumstances. Dr. Wood in this book critically examines the theories propounded in this field and himself contributes a great deal to them. Chapter 1 deals with the various plastic theories, and in his subsequent chapters the author derives upper- and lower-bound solutions using uniform reinforcement. In his upper-bound solution chapter he gives helpful advice on choosing possible yield lines for differently shaped slabs and support conditions. Non-uniformly reinforced slabs are next considered, and then equilibrium methods and the limitations of these (time-saving) devices are discussed. Perhaps the most important contribution to engineering knowledge lies in his chapters on minimising the reinforcement and particularly in his analysis based on compressive membrane action. In this he examines data which have not been generally available and develops a theory for this phenomenon which he compares with experimental data. It is in this field that the major British contribution to engineering science lies.

Lest it be thought that this is a book essentially for the research worker it must be said that the methods of design are illustrated throughout with worked examples, diagrams and excellent photographs, and that a chapter is devoted to practical considerations and aids to design. It is difficult to imagine a more comprehensive book on the subject and engineers for many years to come will be grateful to the author for delving into the subject so deeply and preparing such an excellent book. It is certainly a book which should be studied by all engineers who are at all interested in the actual behaviour of structures and not content with WL/8 or WL/12.

[Reply Card No. 1209]

JANE'S FIGHTING SHIPS 1961–62

Edited by R. V. B. Blackman

Publishers : Sampson Low and Marston and Co. Ltd.

Price 105*s.*

EACH year *Jane's* provides a fund of new and interesting information for those who go down to the sea in ships. For the general reader, less interested in detail but wanting a survey of the changes in the navies of the world in the past twelve months, there is always the Foreword which, in this edition, provides an accurate and comprehensive summary of its contents, leaving little ground for criticism or argument. A number of revised or new illustrations are a regular feature of each new edition and this year these are 380 comprising 317 photographs and sixty-three drawings. The new volume has also been rearranged in that the sections dealing with the various navies have been placed in alphabetical order, thus reverting to the original arrangement followed in the editions issued up to 1902. Whether this is because the United Kingdom no longer has the most powerful navy in the world or because, as the editor points out, *Jane's* is an international publication, it is a more logical lay-out. In any event the Royal Navy still plays a vital part in preserving peace, and *Jane's* does well to emphasise it despite a tendency to overstatement. "The immense power concentrated in the Fleet Arm" is certainly not self-evident. None the less there can be no doubt that the Royal Navy's new amphibious capability in the shape of commando carriers, assault ships and landing craft will do much to ensure that a "brush fire" campaign overseas is quashed or isolated before it is likely to become of vital interest to a major power. The reader may well indeed reflect, in view of the difficulty in finding an adequate number of recruits for the Army, whether a campaign of this kind should not be entirely a sea affair, with Royal Marines providing both the garrisons for the oversea bases and the Commandos for the carriers stationed there. Britain would probably not be fighting alone in a more serious campaign and in any event the Army's Strategic Reserve —however quickly moved by air—would still have to rely on sea transport for the

movement of its heavy equipment and supplies.

It is regrettable that once again *Jane's* makes no distinction, when referring to guided missiles, between the surface-to-surface and the anti-aircraft type. The United States is building or converting many ships to use guided missiles for anti-aircraft defence—and other navies are following her lead. But only a very few of her carriers and cruisers are equipped to fire the "Regulus" and/or "Talos" (dual purpose) missile. On the other hand we are told that the Soviet Navy is now believed to have eighteen conventionally-powered submarines equipped to launch guided missiles and these are certainly not of the anti-aircraft type. Indeed the United States nuclear-powered cruiser "Long Beach" is the only warship yet built or converted to be equipped with an all guided missile armament instead of guns. It is interesting in this connection that *Jane's* now attaches credence to a statement made in this journal a year ago—that Mr. Khruschev is not scrapping his cruisers but converting them into guided missile ships. A study of the Soviet Navy section in fact clearly indicates that Russia is now devoting much attention to anti-aircraft guided missiles for her surface ships and the building of nuclear-powered underwater vessels. The editor estimates that she has between six and twelve nuclear-powered submarines in service or nearing completion, and there is no reason to assume that Soviet scientists and engineers will not soon master the secret of launching missiles from under water. Whether or not east and west also in due course reach a position of "'Polaris' submarine stalemate," these vessels, armed with short-range missiles, would be of great value to the Russians for attacking convoys from a distance and thus well outside asdic range.

Before turning to other foreign navies, the reader who is interested in comparative strengths would do well to note the new warships building for, or acquired by, the Dominion Navies. One is apt to forget the powerful assistance which these navies will provide in the protection of N.A.T.O. sea communications, particularly against submarine attack. Having already under construction four destroyers of nearly 3000 tons and twelve small submarines of 350 tons, the Federal German Navy has now been authorised to build a further eight destroyers of about 6000 tons, large enough to be equipped with anti-aircraft guided missile launching systems. Clearly the latter ships will be based on the British "Devonshire" class now building, and as they have the blessing of N.A.T.O., one must assume that they are the right type of ships required for the defence of the Baltic, which is also the joint responsibility of the Danish Navy. Judging from their building programmes both France and Italy evidently have their minds on a war at sea as a more likely alternative to a mass destruction war in Europe. The second of France's new medium size carriers (22,000 tons) is now nearing completion as is also a novel type of large cruiser (10,000 tons) equipped to operate twelve helicopters and armed with anti-aircraft guided missiles. Italy is building three ships of the size of the "Devonshire" class and two destroyers of 3200 tons, all equipped with anti-aircraft guided missiles. Nonetheless the impression left with the reader, after examining the details of the navies of ninety countries given in this standard work of reference, is undoubtedly one of gratitude for the immense navy of the United States.

[Reply Card No. 1365]

FREILAUFKUPPLUNGEN

K. Stolzle and S. Hart

Publisher: Springer-Verlag, Berlin–Wilmersdorf, Heidelberger Platz 3.

Price DM.31.50

ALTHOUGH freewheel mechanisms have been known for about eighty years, practical applications during the last half century have been confined to a few classes of machinery and vehicles. As in the case of the bicycle, these were of such a specialised nature that their development did not lead to any wider applications. Not until the coming into fashion of automobile overdrives and the employment of freewheels in certain special machinery did designs capable of making a more general appeal come to be be developed. The present work surveys the principal patents in this field and analyses the function and design of the various forms of freewheel. Stress calculations, elastic deformations, inertia, friction, and fatigue all receive consideration. In the section on practical design are dealt with, in addition, such factors as the quality of materials, heat treatment, lubrication and sealing. Of particular interest is the discussion of existing applications to variable speed drives, general mechanical engineering, and vehicle and aeronautical engineering.

[Reply Card No. 1247]

WERKSTOFFPRUFUNG MIT ULTRASCHALL

J. and H. Krautkramer, W. Grabendorfer and L. Niklas

Publisher: Springer-Verlag, Berlin-Wilmersdorf, Heidelberger Platz 3.

Price DM.64.50

IN general, the application of ultrasonics to the non-destructive testing of materials is dealt with as a subsidiary topic in books on ultrasound or on non-destructive testing. The present treatise therefore fills a gap in the literature, especially so as the authors' direct contact with the manufacture of equipment has enabled them to include some of the most recent findings which have not yet been published elsewhere. After discussing the acoustic base of the method, the book turns to a description of the currently employed methods and equipment for ultrasonic testing. Techniques of application imply means of coupling workpiece and generator, the factors determining the choice of frequency and the type of generator head, spurious echoes caused by internal reflection and surface waves, and other causes of errors, and methods for determining the size and location of flaws, as well as the organisation of a testing department and the training of personnel. The testing of metallic workpieces is described in great detail, attention being paid to the various classes of component (forgings, castings, machined parts, rolled material, &c.) and joints (welds, riveted joints, soldered or glued joints, shrink fits, &c.) whether of ferrous or non-ferrous material. Special problems are revealed in the testing of non-metallic items (ceramics, glass, plastics, concrete, organic substances such as foodstuffs, &c.), and in medical applications. Certain uses of ultrasound in the determination of liquid levels in containers, the presence of air bubbles in pipes, the direction of deep drill holes in workpieces, and similar instances, are also described. Of interest to the practical tester will be found the review of regulations and test specifications in force in European countries and overseas. Tables and diagrams complete the book.

[Reply Card No. 1246]

Books of Reference

Technical Data On Fuels. Sixth Edition. Edited by H. M. Spiers. British National Committee World Power Conference, 201, Grand Buildings, Trafalgar Square, London, W.C.2. Price £3.—The sixth edition of *Technical Data On Fuel* incorporates a number of major changes from earlier editions. The page size has been increased, allowing a better relationship between text, on the one hand, and tables and diagrams on the other, to be obtained, and also the placing of most of the tables on a single page. The text and tables have been reset, and the subject matter rearranged in what is thought to be a more logical sequence.

The contents of the sixth edition have also undergone extensive revision. Many tables have been recalculated, and symbols made to conform with B.S. requirements. Those sections of the text which have been extensively revised include the following subjects: temperature measurement; heat transfer; barometer corrections; viscometry; the detonation of liquid fuels; the properties of solid fuels; the properties of tars; and the properties of alloys at elevated temperatures. The measurement of fluid flow is now described according to the new B.S. code.

Various new topics are included in this edition. They include a chapter on atomic energy and nuclear fuels, a section on the viscosity blending of fuel oils and one on flow in fluidised systems.

[Reply Card No. 1217]

Merchant Ships: World Built, 1961. Adlard Coles, Ltd., 7, Brunwick Place, Southampton. Price 35s.—This book is Volume IX of this comprehensive annual illustrated register of new ships, and deals with the tonnage launched in 1960. In the introduction A. C. Hardy, B.Sc., discusses the world shipbuilding situation, passenger liners, cargo liners and bulk carriers, coastal and short sea traders and trends in propelling machinery. There are two parts. Part 1 contains particulars of merchant ships of over 1000 tons gross set out in alphabetical order, many of the ships being illustrated or having plans reproduced. Smaller ships of under 1000 tons gross are illustrated, and there are notes upon coasters, fishing vessels, tugs and miscellaneous craft. In the final section of the book figures are published, from Lloyd's Register, of merchant ships launched in 1960, including the totals of individual countries, together with additional details of launches in the leading countries abroad. The new volume retains all the essential information of the earlier works, but certain regrouping has been carried out and duplication of material eliminated.

[Reply Card No. 1386]

Fedération et Syndicats des Industries Méchaniques et Transformatrices des Métaux. Annuaire 1960–61. 11, Avenue Hoche, Paris, 8e. Price 50.00 N.F.—This current handbook presents information about all sections of the French mechanical engineering and metal processing industries. It is divided into five sections: an introduction (in German, English, Spanish and French); a list of related trade organisations and institutions; a list of affiliated trade organisations and summaries of their internal organisation; an alphabetical index of member firms; and a classified products list.

[Reply Card No. 1214]

Industrial Finishing Yearbook, 1961. Arrow Press, Ltd., 157, Hagden Lane, Watford, Herts. Price 15s.—The latest edition of this yearbook gives a comprehensive survey of the whole field of Industrial Finishing, and includes sections on, workshop practice, materials and processes, and technology. A buyers' guide and trade directory, and a list of professional and trade organisations, are also included. Due to the increased listing of manufacturers and suppliers in this edition, the entries have been almost doubled, and a more detailed classification of products has resulted. The technology section has also been extensively revised and is supplied with its own index, the sub-section concerning British Standards on industrial finishing being especially useful.

[Reply Card No. 1387]

Crude Oil Tanker "Sepia"

THERE has been built and engined by Cammell Laird and Co. (Shipbuilders and Engineers) Ltd. the oil tanker "Sepia," which has been handed over to Shell Tankers N.V., Rotterdam and is the second of the 66,000 tons deadweight tankers ordered for the Royal Dutch/Shell Group. As for "Serenia," the first of the three ships, described in our issue of July 28, the ship will be mainly employed in carrying crude oil from the Middle East to terminals in north-west Europe, principally at Tranmere, for Stanlow refinery, and at Europort for Pernis refinery. Our aerial view of the ship on trial illustrates its distinctive appearance, enhanced by the twin funnel arrangement which has been designed on the basis of wind tunnel tests to ensure that by a combination of shape, height, and high velocity of emission, the funnel gases will be carried well clear of the ship.

Aerial view of "Sepia" on trial on the Clyde

The tanker is longitudinally framed; it has twin continuous longitudinal bulkheads, a centreline wash bulkhead, vertically stiffened transverse bulkheads, and a curved raked contour plate stem. The main dimensions and particulars are:

Length overall	817ft 9in
Length between perpendiculars	775ft
Breadth moulded	112ft 6in
Depth moulded	57ft 9in
Draught	42ft 10½in
Deadweight	67,120 tons
Cargo tank capacity	2,969,000 cubic feet
Gross tonnage	42,109·3
Propelling machinery	22,000 s.h.p.
Service speed	16·5 knots

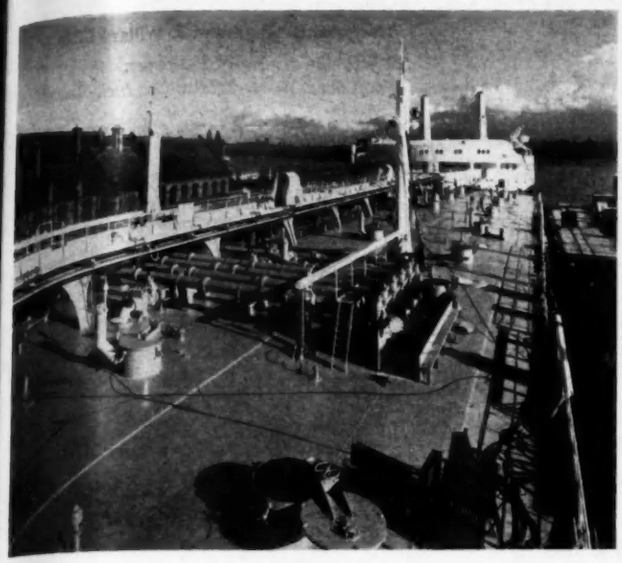
Hull sub-division provides forepeak, deep tanks, fourteen sets of cargo and ballast compartments, pump room and bunkers, machinery space and aft peak. Each set of cargo and ballast compartments is divided into three by the longitudinal bulkheads and of the forty-two spaces so formed, nine compartments, namely, No. 1 centre and Nos. 1, 8, 9 and 10 port and starboard tanks, are reserved for the carriage of 14,500 tons of sea water ballast. The capacity of the remaining tanks, when loaded with crude oil of 0·82 specific gravity, will bring the ship down to her tropical draught. Ballast compartments are coated throughout with two coats of "Epikote" coal tar paint and the deckhead and the top 5ft of the steelwork in the remaining wing tanks are similarly treated as a measure of protection against corrosion. The latter set of tanks are also cathodically protected.

The view of the upper deck, looking aft from the midships deckhouse, which we reproduce, shows the arrangement of deck piping and hatches to tanks and also the new design of fore and aft gangway supports, consisting of widely-spaced arched plates, to give more deck space and so provide better maintenance facilities. Deck machinery consists of an Emerson Walker turbine-driven cable lifter and other units, supplied by Clarke Chapman and Co. Ltd., include two turbine-driven capstans mounted on the forecastle and two capstans of similar mark on the poop. In addition, there are six semi-automatic self-tensioning winches, of which two are on the boat deck aft, one on the main deck aft, one on the foredeck, and two at the forecastle. There is also a steam winch on the main deck. The oil-tight cargo oil pump room is externally lighted by mercury vapour lamps and equipped with six Drysdale turbo-driven vertical spindle centrifugal pumps, four of which are rated at 1900 water tons per hour against a pressure of 120 lb per square inch at the ship's rail and allocated for handling cargo oil, and two have a capacity of 2000 tons per hour against a head of 30 lb per square inch for dealing with clean water ballast. For tank stripping there are three J. P. Hall 200 tons per hour duplex steam-driven reciprocating pumps and also mounted in the pump room is a 150 tons per hour water-driven ballast stripping eductor, powered by one of the main ballast pumps. Forming the cargo piping system are four 18in o.d. main lines with 16in o.d. centre tank suctions and 12in o.d. wing cargo tank suctions, while crossovers enable any cargo pump to draw from any tank. Three lines of 10in and 8in diameter form the stripping system and for clean ballast there is a 14in main line with 10in suctions to the permanent ballast tanks. For heating purposes there is a combined conical/grid system and the 16in diameter suction valves at the centre tanks are power-operated by a four-cylinder radial air motor of 3 h.p. Cleaning of the cargo tanks is effected by machines supplied with hot water by a turbine-driven centrifugal pump having a rating of 320 tons per hour against a head of 420ft, the water being supplied by a heater capable of raising the temperature of 1000 gallons per minute from 50 deg. to 180 deg. Fah. Two fans, each driven by a 250 h.p. impulse turbine and able to deliver 14,000 cubic feet per minute of air at 50in water gauge, are used for gas freeing and ventilation of the tanks. The gas is discharged through a nozzle which terminates 6ft above the deck and is mounted on the hatch coaming at each tank.

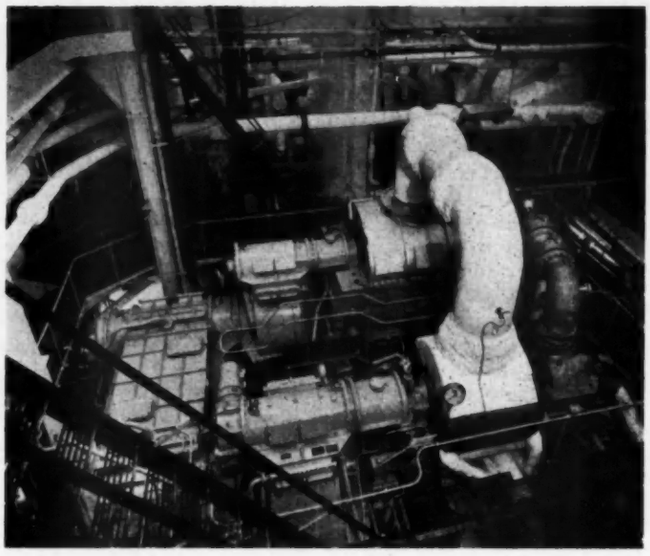
Spacious accommodation is available for the officers and crew, the captain and chief engineer having extensive suites and all deck officers and engineer officers, down to the fourth, having private baths. The crew have individual cabins and the mess spaces include jardinieres as part of the decoration. The accommodation is provided with an air conditioning system, mechanical ventilation and heating.

Propelling and Auxiliary Machinery

For propulsion purposes there is a single set of double-reduction geared turbines of Pametrada design which develops 22,000 s.h.p. at 108 propeller r.p.m. when taking steam at 570 lb per square inch gauge and 880 deg. Fah. and drives a five-bladed "Nikalium" propeller of 23ft diameter by 17·65ft pitch. We include a general view of the engine room, showing turbines and gearing. The double casing ahead h.p. turbine has twelve single-row impulse stages, and each flow of the double flow l.p. ahead turbine has five single-row impulse stages followed by five reaction stages. For astern working 11,000 s.h.p. is available and is developed by a two-row impulse wheel h.p. astern turbine carried on an extension of the h.p. ahead rotor, and an l.p. astern turbine consisting of two single-row impulse stages forming an integral part of the l.p. ahead rotor. The two-flow spring-mounted regenerative condenser, forming part of the Weir feed system, has a surface area of 15,100 square feet and maintains a vacuum of 28½in Hg. with a sea temperature of 75 deg. Fah. The scoop-assisted condenser circulating system is supplied by a 22,000 gallons per minute turbine-driven axial flow pump. In addition to reducing entry losses, lips have been fitted to the forward



Upper deck looking aft from the bridge



General view of the engine room

edges of the discharge orifices to reduce losses at these points. For dealing with the condensate, there are two 160,000 lb per hour motor-driven extraction pumps which discharge through the gland/air ejector condenser and the distiller of an evaporator to the deaerator. From the latter, two multi-stage centrifugal main feed pumps, driven by turbines taking steam at boiler pressure and exhausting at 15 lb per square inch gauge, discharge at 240,000 lb per hour at 740 lb per square inch gauge to the main boiler economisers where the feed water is raised in temperature from 240 deg. to 310 deg. Fah. On trial a consumption of 0·502 lb per s.h.p. per hour was achieved.

Steam is raised by two Babcock and Wilcox "Selectable Superheat" water tube boilers, each fitted with welded superheater, stud tube condenser, cast iron gilled tube condenser and bled steam air heater. Each boiler has a normal evaporation rate of 80,000 lb per hour and a maximum of 95,000 lb per hour and generates steam at 600 lb per square inch gauge and 900 deg. Fah at the superheater outlet. The heating surfaces of the boiler tubes, superheater, stud tube economiser and gilled tube economiser are 8957, 1950, 1443 and 5645 square feet respectively. Wallsend oil burning equipment is installed and includes two motor-driven horizontal screw pumps, each having a discharge rate of 15,000 lb per hour of Bunker C fuel at 450 lb per square inch, and three steam fuel oil heaters, any two of which will raise the temperature of 14,000 lb of oil per hour from 100 deg. to 300 deg. Fah. The burners have a turn-down ratio exceeding 6 to 1 and are designed for both pressure-jet and steam-assisted atomisation. There is no boiler lighting-up fan, but air is ducted from a supply fan for this purpose. An automatic combustion control system for fuel and air supplies has been fitted, and the Bailey combustion control board is sited adjacent to the machinery manoeuvring console. Mounted side by side between the boiler uptakes are two Howden motor-driven F.D. fans, each capable of delivering 32,000 cubic feet of air per minute at 100 deg. Fah. against 19·9in water gauge.

An external desuperheater with twin water sprays is fitted, and a thermostat adjusts the volume of spray water automatically to control the temperature of the output steam. Should the steam exceed a preset figure an over-riding thermostat shuts the system down, a similar result being effected should there be a failure of operating air. At the forward end of the engine room are the turbines driving the cargo and ballast pumps; desuperheated steam at boiler pressure is used and the exhaust, together with that from other auxiliaries, is led to a Buckley and Taylor "U"-tube condenser. Two Weir single-effect sea water evaporating and distilling plants are installed, each operating on exhaust steam at 10 lb per square inch gauge; one is circulated by the condensate in the main boiler feed system and produces 3500 lb per hour of distilled water and the other, which produces 5500 lb per hour, is salt water circulated.

Other auxiliaries include: a Thom, Lamont oil fuel transfer pump, a Hayward-Tyler general service pump, two Worthington-Simpson and one Stothert and Pitt fire and bilge pumps, Sutcliffe and Speakman water filter and dechlorination plant and Worthington-Simpson air compressors having ratings of 25 cubic feet per minute at 100 lb per square inch and 30 cubic feet per minute at 50 lb per square inch. Lubrication of turbines and gearing is on the pressure-gravity system which includes: two Stothert and Pitt motor-driven forced lubrication pumps each of 500 gallons per minute capacity against 45 lb per square inch, a De Laval purifier, and two Serck oil coolers, each having a duty of reducing the temperature of 500 gallons per minute of oil from 135 deg. to 110 deg. Fah. when supplied with sea water at 75 deg. Fah. Michell thrust block and shaft bearings are provided, and the stern tube, which has a mechanical seal at inner and outer ends, is white metal lined and oil lubricated, since water lubricated bearings are subject to considerable wear when high power is transmitted to a single screw.

To provide the necessary electrical power there are two 600kW Allen back-pressure turbo-alternator sets in which the impulse turbines run at 11,500 r.p.m. and drive the alternators at 1800 r.p.m. through a single-reduction, parallel-shaft, double-helical gear. They operate with steam at 575 lb per square inch gauge and 880 deg. Fah. and exhaust at 15 lb per square inch gauge to the low pressure steam range, so that condensers are not required. The alternators are wound for 440V, three-phase 60 c/s supply and are arranged for parallel operation with each other and with the 125kW emergency alternator, which is powered by a six-cylinder National diesel engine. The Whipp and Bourne switchboard incorporates Brookhirst Igranic group starter boards and the busbars are divided into sections by movable links.

To protect the boiler room, cargo pump room and deck there is a "Pyrene" foam fire-fighting system, there being foam makers and spreaders in the boiler and cargo pump rooms and foam-making monitors and portable foam-making branch connections fitted to the main deck line. The foam-making storage tank is pressurised to 100 lb per square inch gauge. For the service of the engine room personnel and for handling stores, there is fitted at the forward end of the machinery space a lift, supplied by Rendale Cranes Ltd., which is capable of lifting 1 ton at 50ft per minute and operates between the control platform and the three accommodation deck levels. Ventilating of the machinery spaces is effected by six "Axia" fans, each rated to supply 34,700 cubic feet of air per minute at 1½in water gauge, four of which provide air for the engine room while two supply the boiler room. In addition, there are two engine and two boiler room exhaust fans, each having a capacity of 30,000 cubic feet per minute at ½in water gauge.

British Standards Institution

All British Standard Specifications can be obtained from the Sales Department of the Institution at 2, Park Street, London. W.1.

ZINC COATINGS ON IRON AND STEEL ARTICLES
PART 1. HOT DIP GALVANISED COATINGS
PART 2. SHERARDISED COATINGS.

No. 729 : 1961. Part 1. Price 4s. Part 2. Price 3s. The revised edition of this standard has been divided into two parts to cover hot dip galvanised coatings and sheradised coatings respectively. The earlier standard specified visual examination and Preece copper sulphate dip continuity test for coatings. The revised standard introduces requirements, in Part 1, for weight of coating as well, giving three alternative methods of determination. Guidance is given on threaded work and an accepted procedure indicated. In Part 2, visual examination and the copper sulphate dip test alone are specified and recommendations for threaded work are included.

COUPLINGS FOR BULK HANDLING OF ANIMAL FEEDING STUFFS AND GRAIN

No. 3362 : 1961. Price 4s.—This standard was prepared at the request of the National Association of Corn and Agricultural Merchants, and it lays down materials and dimensions for screwed couplings of the fire hose type, which have been simplified for use with bulk vehicles when only one man is available for coupling and uncoupling. Another design, of American origin, is shown in an appendix, together with adaptors, and it is stated that this design may be introduced into the standard later if it proves satisfactory in use.

Letters to the Editor

POLLUTION OF THE TIDAL THAMES

SIR,—Permit an electrical engineer—and fly-fisherman—to trespass a little on the biologist's territory. It was good to read your editorial and your revealing review of the official reports of the two fact-finding bodies. Having not yet read these reports myself, I may flaunt my ignorance in suggesting that a sound body of water, well handled, can digest a heavy load of pollution.

Disregarding the influx of poisons from ill-regulated industrial discharges, and accepting the rather stale and warm outflow from central power stations as an aid rather than a hindrance, we will attempt a quantitative approach to the problem. It seems that the broad margin of tolerance, as Pettenkofer first taught us, the miracle of metabolism which we now exploit in hydroponics and in the mass production of edible algae, breaks down wholesale after the dissolved oxygen is consumed. Surely, much of the lasting damage inflicted on our rivers everywhere can be ascribed to shock loads. Not just to poisons, but to overdoses of what a gardener would recognise, from your lucid description of a river's digestive processes, to be organic and anorganic manures, however ill assorted. From his own plants, the gardener also knows about photosynthesis. This process helps one part of the wide and active range of aquatic life to satisfy the basic needs of the other. Aerobe forms, e.g. normally oxygen-producing bacteria, produce carbon dioxide by night. Though basic to the metabolism of a sheet of water, this is not the stuff in short supply. It is easily split off, by an even wider anaerobic range of the aquatic flora, from decaying organic substances, from the carbonates of lime and other elements.

To solve this most pressing problem is to apply the right amount of air-entrained oxygen at the right time and at the right place. This is definitely not at the outlet of the worst offending sewage works. Let us not be afraid of stop-gap solutions when the problem as a whole threatens to overwhelm us. Artificial aeration on a large scale has worked successfully on the Flambeau River Scheme in U.S.A. from 1944 onwards. The technique is well understood, its application perhaps less so. Absorption rates were somewhat disappointing, one in five parts only being retained. This might have been improved, perhaps, if ozone had been added to the air stream as a primer or catalyst. This process, at least to the extent we can afford to apply it, is seen to fail where the body of water has already succumbed. We should try again, it is felt, at points upstream and close to the sources of pollution, where mineral concentration has not yet proved overwhelming. The natural rate of oxygen intake by climatic action fluctuates excessively, and should be evened out by human air. Selected points, where the whole sheet of estuary or river water just fails to break through the barrier of biological oxygen demand, and so starves all of its recuperative powers, promise the best return for the engineering effort invested. It is thought that a purely locally applied, or mobile system of oxygen inoculation may effect the desired break-through and so establish islands of resistance. These are likely to spread, there being no dearth of food, and generate their own supplies of O_2 and CO_2 as they float along.

H. S. HAYES

Frankfurt-on-Main,
November 13, 1961.

Books just published

Fundamentals of Electrical Measurements

336 *pages. Diagrams.*
Publisher : George G. Harrap and Co. Ltd.
by C. T. BALDWIN, M.A., M.I.E.E.
Price 25s.

The aim of the author is to give a concise theoretical and practical introduction to electrical measurements for H.N.C. and H.N.D. students. The emphasis here is on fundamentals, and the work is largely confined to methods at power-frequencies and audio-frequency, although a small part of the book is devoted to the principles of measurement at higher frequencies and in high-voltage work. The rationalised system of M.K.S. units is used throughout the book. The text is divided into eighteen chapters each of which deals with one type of instrument or measurement. Worked examples are included in the text, and sample questions from examination papers are found at the end of each chapter. Other parts are bibliography, answers to exercises, appendix on measurement of non-electrical quantities, and an index.

[Reply Card No. 1289]

Basic Physics of the Solar System

307 *pages. Illustrations. Diagrams. Maps.*
Publisher : Addison-Wesley Publishing Co. Inc.
by V. M. BLANCO and S. W. McCUSKEY.
Price 64s.

Written for scientists and engineers who are not specialists in astronomy, this book offers a concise presentation of basic physical and dynamic aspects of the solar system. It is intended for those interested in space technology, and aims to bridge the gap between elementary books on astronomy and the more specialised literature. Chapters include astronomical co-ordinate systems, planets and their satellites, Moon-Earth system, celestial dynamics, and Sun and interplanetary space. Also included are plates of planets, comets and various aspects of solar activity ; a lunar map ; an index ; and an appendix of conversion tables and physical and orbital characteristics of planets and satellites.

[Reply Card No. 1291]

Water Hammer in Hydraulics and Wave Surges in Electricity

293 *pages. Diagrams.*
Publisher : John Wiley and Sons Inc.
by L. BERGERON
Price £6

This is a translation of the French edition " Du Coup de Bélier en Hydraulique au Coup de Foudre en Electricité " published by Dunod, Paris in 1949. The book is intended to be a straightforward exposition for hydraulic engineers of the graphic method of calculating water hammer ; various examples are given, and applications for other branches of mechanics are discussed.

[Reply Card No. 1319]

The Scientific Papers of J. Willard Gibbs

2 *vols.* 434 *pages and* 284 *pages.*
Publisher : Dover Publications Inc., Constable and Co. Ltd.
by J. WILLARD GIBBS, Ph.D., LL.D.
Price $4.

Elementary Principles in Statistical Mechanics Developed with Especial Reference to the Rational Foundation of Thermodynamics

207 *pages.*
Publisher : Dover Publications Inc., Constable and Co. Ltd.
by J. WILLARD GIBBS, Ph.D., LL.D.
Price $1.45.

Vector Analysis, a Textbook for the Use of Students of Mathematics and Physics

436 *pages.*
Publisher : Dover Publications Inc., Constable and Co. Ltd.
Founded upon the Lectures of J. WILLARD GIBBS, Ph.D., LL.D. by EDWIN BIDWELL WILSON, Ph.D.
Price $2.

Four further volumes in the Dover paperback series of reprints of technical classics are devoted to the complete works of J. Willard Gibbs (1839–1903), the foremost American mathematical physicist of his day. The *Scientific Papers* consist of an unabridged republication of the collected papers first published by Longmans, Green and Co. in 1906. Vol. 1 contains the papers on thermodynamics and Vol. 2 papers on dynamics, vector analysis and multiple algebra, the electromagnetic theory of light, and miscellaneous papers. The *Elementary Principles in Statistical Mechanics* was first published by Yale University Press in 1902. The volume on *Vector Analysis* was based by Dr. Wilson upon the lectures given by Professor Gibbs at Yale University in the year 1899–1900, and this edition is a republication of the 2nd edition published by Charles Scribner's Sons in 1909.

[Reply Card No. 1320]

Principles of Vacuum Engineering

578 *pages. Illustrations. Diagrams.*
Publisher : Chapman and Hall, Ltd.
by M. PIRANI, Ph.D., F.Inst.P., F.S.G.T., and J. YARWOOD, M.Sc., F.Inst.P.
Price 105s.

This survey of vacuum science and technology is intended for the final year student or the post-graduate worker. The material has been selected to give descriptions of most of the basic apparatus and techniques and the emphasis is on the practical aspects of the subject. There are author and subject indexes and a long bibliography.

[Reply Card No. 1321]

Successful Communication in Science and Industry : Writing, Reading and Speaking

290 *pages. Diagrams. Tables.*
Publisher : McGraw-Hill Publishing Co. Ltd.
by ROBERT L. ZETLER and W. GEORGE CROUCH.
Price 45s.

The book is divided into three sections, Part 1, Technical Writing, Part 2, Reading Techniques, and Part 3, Speaking Techniques ; it is written for students, scientists and businessmen, and is intended to be keyed to the special problems of industry and science. Part 1 deals with grammar, basic forms such as technical reports, journal articles and business letters, and their relationship to techniques of exposition. Part 2 is concerned with reading speed, comprehension, skimming, number recognition, and determination of word meanings through context. The last section is about methods of organisation and effective presentation of speech, both to small groups and large audiences. Problems, examples, questions and discussion topics are also included in the text. There is a short index.

[Reply Card No. 1292]

Electric Heat Treatment Furnace of Low Thermal Mass

By R. McGlashen, M.I.E.E., A.M.I.Mech.E.*

The author began developing the low-thermal-mass furnace about four years ago. It is used primarily for stress relieving of welded structures, but is capable of other operations. Its economics are striking: one-quarter, or less, of the cost of conventional furnaces; fuel costs comparable with those of gas or oil furnaces on full load, and much less on partial load; negligible maintenance costs; automatic operation and virtually no labour costs; up to three times the throughput of conventional furnaces of the same size, and elimination of job scaling, as a side benefit. The article describes how the conception was developed, the form of construction, results of the first year's operation, and outlines the economic advantages.

Conception and Development

At the urgent request of John Thompson (Wilson Boilers) Ltd. of Glasgow, the South of Scotland Electricity Board Industrial Advisory Service designed a large heater to be used for pre-heating to 200 deg. Cent., sixteen 11-ton assemblies destined for Berkeley nuclear generating station. The equipment was constructed in a few days from domestic cooker grill boiler hotplates. It was very successful and costs were so low that a director of John Thompsons casually remarked to the author that a real boon to them would be an electric means of stress relieving their range of "Multipac" welded boilers, if the electrical equipment construction and operating costs were as relatively low as had been those for the pre-heating rig.

It needed only a few calculations to show that under optimum conditions it should be possible to raise a ton of steel to stress relieving temperature for about 10s. worth of electricity, on one of the South of Scotland Electricity Board's off-peak tariffs. As John Thompson reckoned that at that time it was costing over £9 per ton to send out their work for stress relieving, and all of the day-to-day stress relieving work was being carried out in fuel-fired furnaces, clearly there was a case for investigation.

Experiments carried out by the Board, confirmed the low cost of electricity needed for such operations, and work was started on devising the best means of application.

A high proportion of the heat input to even the best of conventional furnaces is soaking into massive walls and passing out of flues in waste gases, rather than going into the work piece. To avoid these disadvantages, the first approach to the problem was virtually to make the job to be stress relieved act as its own furnace, by locating the heat source inside the job. For this purpose an electric heater was developed to work at ordinary mains voltages, rated at 4kW per foot run in surroundings at 650 deg. Cent. The heater comprises tubular units 8in diameter and 6ft long which can be bolted end to end to form a single heater of any length up to 60ft, requiring an electricity supply at one end only. Such heaters are intended to be inserted into boilers and similar structures, which are then covered with thermal insulation and brought up to stress relieving temperature.

This system is useful for very large welded vessels, but it is not easily applicable to flat or irregular shapes, and a disproportionate amount of labour is required to fit the heaters into small boilers. Attention was therefore turned to other ways of applying electroheat, still keeping rigidly to the idea behind the tubular heaters, that as high a proportion as possible of the heat used should go into the job itself.

The outcome was a large diving-bell type of construction to lower over the job (Fig. 1). The 3in thick moulded block walls of the bell were thinner and lighter than had ever before been used in furnaces to operate at that temperature. The only brickwork used was in the form of a few circumferential runs at intervals up the sides to carry heating elements, which were disposed over all internal surfaces. Virtually all internal metal work had been eliminated. To cater for loads of varied shapes, small holes with removable stoppers were left in the base so that job supports could be plugged through to the cool steelwork beneath.

The entire furnace, having clear internal dimensions of 18ft by 12ft by 12ft was so light that it was possible to mount it on roller bearing wheels and tow it across the factory, complete with a 25-ton load, by means of a fork-lift truck. This light weight meant also that the furnace could be built completely in a works in England, brought by road to Scotland, and commissioned immediately.

Since that date, more than a year has passed; the conception has proved entirely successful as the following operational results will show.

Direct Advantages

The direct advantages have been low capital cost, low operating costs, and negligible maintenance costs.

Capital Cost.—One characteristic of the low thermal mass form of construction is its low cost. The John Thompson furnace referred to above cost less than £6500 as compared with capital costs four times (or more) as great for conventional furnaces of the same cubic capacity. This low capital sum was fully recovered by John Thompson through direct savings in stress relieving contract costs over less than twelve months.

Electricity Costs.—During the year, 950 tons of boilers were stress relieved in 141 heats, at an average cost for electricity of £1 0s. 3d. per ton. This cost compares favourably with the known fuel costs of fuel-fired furnaces of this size. The actual cost of operation was well above the minimum possible cost, because the furnace was almost invariably only part loaded with less than 7 tons. It was in fact designed to take a 13-ton optimum normal load, and occasional 25-ton loads. Other firms might find it convenient to operate regularly a heavier loading policy, and Fig. 2 which has been derived from an analysis of the past year's

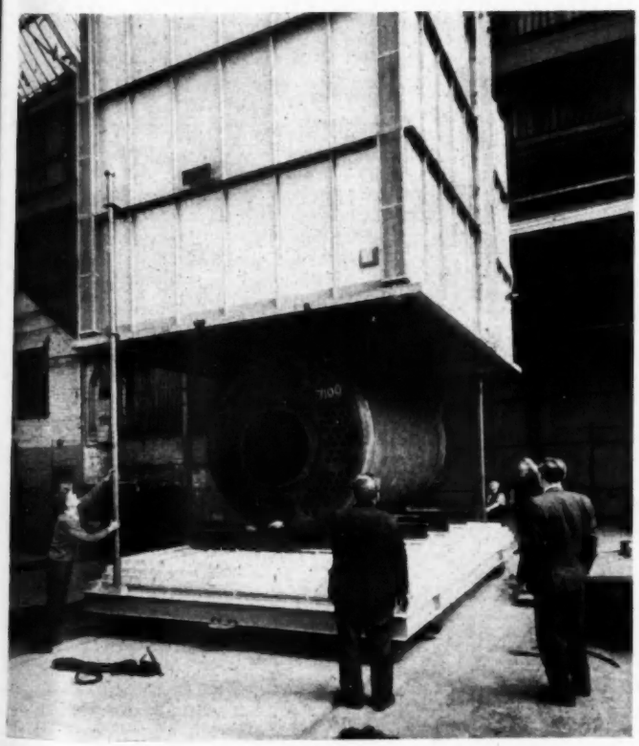


Fig. 1—The low thermal mass furnace

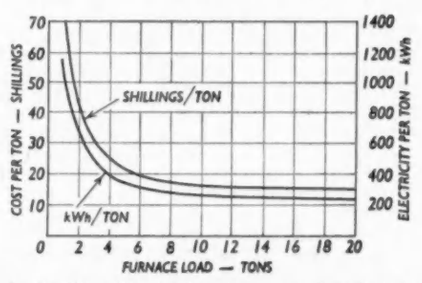

COST PER TON — SHILLINGS
ELECTRICITY PER TON — kWh
SHILLINGS/TON
kWh/TON
FURNACE LOAD — TONS
0 2 4 6 8 10 12 14 16 18 20
10 20 30 40 50 60 70
200 400 600 800 1000 1200 1400

Fig. 2—Electricity (and cost) per ton of work stress relieved

* Head of Industrial Development Section, South of Scotland Electricity Board.

working, shows the relationship between furnace load and cost of electricity per ton of load, for stress relieving. Supply was given on the S.S.E.B. off-peak tariff No. 1 (0·75d. per unit).

Labour Costs.—Labour is required only for the twenty minutes needed to unload and re-load the furnace. Operation is fully automatic under the control of three cam-type regulators which are brought into operation by means of a time switch at night time when the factory is deserted.

The complex temperature and time schedule prescribed by B.S. 1500 (Fusion-welded Pressure Vessels) is closely adhered to and furnace temperature is charted to satisfy the boiler insurance inspectors.

Maintenance Costs.—The only maintenance necessary during the year was replacement of a single thermal insulation block, which was displaced during delivery, and the repair by welding of an open-circuited element. Both the thermal insulation and the elements are operating at temperatures well below their permitted maxima ; there is no deterioration visible in either and it is expected with confidence that no maintenance will be required for some years.

Replacement of the whole thermal insulation lining and the elements, when it finally becomes necessary, will be an inexpensive procedure, compared with the rebricking of a conventional furnace.

Indirect Advantages

The indirect financial advantages of the low-thermal-mass electric furnace are so outstanding that they even outweigh the direct advantages.

Combination of Speed and Low Temperature Gradients.—For the average load, a complete cycle of loading, stress relieving and re-loading, can be completed in less than twenty-four hours. Fig. 3 shows the relationship between furnace load and cycle

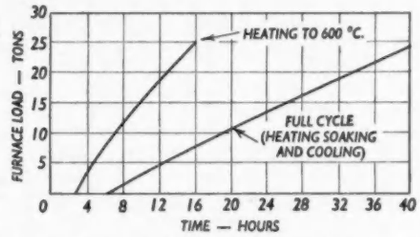


Fig. 3—Stress relieving cycle. Relationship of furnace load with cycle time

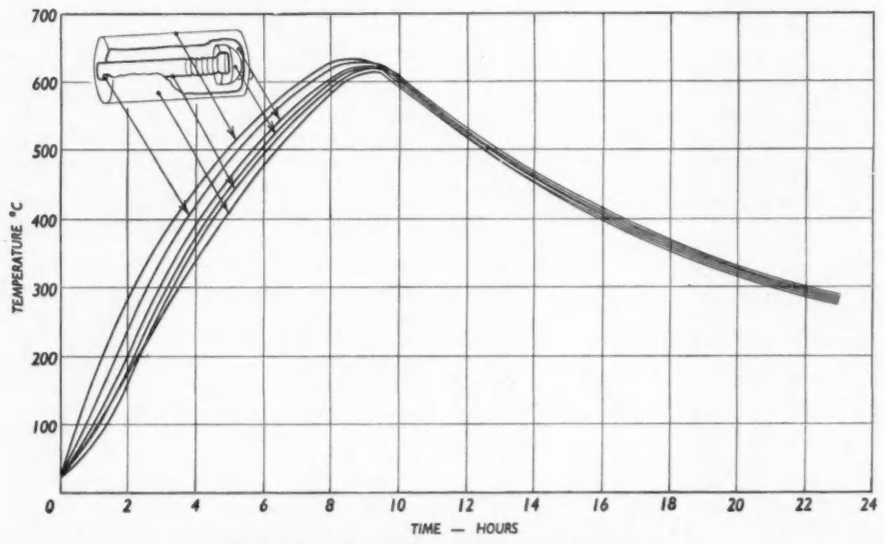


Fig. 4—Temperature on 10-ton boiler during stress relief

Hatched area indicates B.S. 1500 limits.

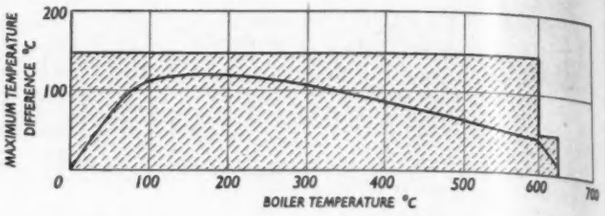


Fig. 5—Maximum temperature gradient in boiler during stress relief

times. The one-day heating, cooling and re-loading cycle on normal loading, gives up to 200 per cent greater throughput compared with a much more expensive conventional furnace occupying the same amount of floor space.

A temperature/time chart for a complete heating and cooling cycle, taking twenty-two hours in the low thermal mass electric furnace, is reproduced in Fig. 4. The low level of temperature gradients throughout a boiler being stress relieved is noteworthy, and the extent by which the gradients fall within the limits prescribed by B.S. 1500 is shown in Fig. 5.

Structures of such mechanical complexity with parts forming internal radiation barriers had not previously been stress relieved by a heat source of a predominantly radiant nature. It was not in fact possible to calculate in advance what the gradients would be, and the firm constructing the furnace would not guarantee acceptable results. The S.S.E.B. however promised John Thompsons that they would, if necessary, modify the design and construction of the furnace to make it give results within the limits prescribed by B.S. 1500. No modifications were needed though, as temperature gradients from the start were within the B.S. 1500 requirements.

Elimination of Scaling.—The diving-bell form of furnace construction tends to trap hot air, and when the oxygen in that air has combined with the workpiece, the atmosphere remaining is non-oxidising. The effect of any small air leakages which might exist is minimised by the short time cycle for the heating operation. It has been found in practice that scaling is entirely eliminated ; the jobs are covered with only a light dusting of oxide. In Fig. 6 oxidation is compared on jobs which have been stress relieved in the low-thermal-mass furnace and in a fuel-fired furnace.

Direct financial savings on scaling costs are estimated by John Thompson to be worth at least as much as the total amount of electricity consumed for stress relieving.

Effects on Productivity

The several advantages of the low-thermal-mass furnace have had a cumulative effect on productivity. It would be difficult to place a cash value on these production aspects but they clearly must represent an additional financial saving as important as the direct and indirect economic advantages listed above.

The extremely slow rate of deterioration of furnace elements and lining will give an almost total freedom from furnace outages. Such outages with fuel-fired plant are often unplanned, frequently extend to weeks at a time, and have an adverse influence on production flow.

Operating costs are so low that it has been found economic to load the furnace at times with as little as one small boiler if this procedure would serve to hasten the production schedule. This feature has proved of great benefit to John Thompson

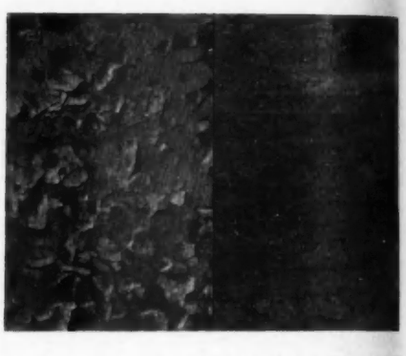


Fig. 6—Part of mild steel plate after stress relieving cycle. (Left) in fuel fired furnace ; (right) in low-thermal-mass electric furnace

in using the furnace as a production tool. They have never needed to wait for a full furnace load to accumulate when the financial penalties of partial loads have been so slight.

Production advantages of rapid throughput are most marked where jobs have previously had to be sent out for contract stress relieving. Transport time, waiting time at the contractor's works for a full furnace load to accumulate, and a long stress relieving time cycle in a conventional furnace before the job was returned, used to take anything up to ten days for each of John Thompson's boilers. Accurate pre-planning of further production processes used to be impossible because of the indeterminate date of return from stress relieving.

Elimination of the scaling operation has resulted in shorter overall process times, and the freeing of floor space formerly required for this operation has played its part in the achievement of a rapid expansion of boiler production. There has also been a marginal benefit to John Thompson's customers from the increased boiler strength where the steel work has retained its full original thickness.

Acknowledgments

The author wishes to acknowledge the encouragement and support for the project which he received from Mr. Victor S. Ruff,

managing director of John Thompson (Wilson Boilers) Ltd., and from the main board of the John Thompson Group.

The furnace described above was constructed by Shelley Electric Furnaces Ltd., Stoke-on-Trent, who now have others under construction. G.W.B. Furnaces Ltd., Dudley, Worcs., also have designed furnaces of the same type with the co-operation of the South of Scotland Electricity Board.

A 16mm colour film with magnetic soundtrack, showing form of construction and methods of operation of the low thermal mass furnace, has been produced by the Commercial Department of the South of Scotland Electricity Board, and is available for free loan to interested parties from S.S.E.B. Head Office, Inverlair Avenue, Glasgow, S.4.

[Reply Card No. 1385]

Modernised Industrial Textile Factory

An important part of the Dunlop organisation is that of Dunlop Textiles Ltd., which is responsible for supplying the woven fabrics made from cotton, rayon and nylon to the tyre, belting, footwear and other factories within the organisation, as well as to a number of outside concerns. The main mill of Dunlop Textiles Ltd., is at Rochdale and it controls subsidiary factories at Hindley Green, Dunfermline, Bidston and Londonderry. Under a re-equipment programme inaugurated seven years ago extensive improvements have been carried out at these factories to modernise all the spinning and weaving processes and to take advantage of the latest techniques and plant to improve the final products, promote economies in production and labour, and to improve working conditions. For this programme an expenditure of £2,500,000 was authorised. In carrying a scheme of this size a particular problem is to maintain a required level of production when removing, re-arranging and replacing plant, and in the case of the Rochdale mill this work was further complicated by a fire which last year damaged some of the new plant and the main factory structure. Despite this set-back the programme was maintained and when it is completed in three year's time the factory will be one of the most modern of its kind in the world.

Direct sliver spinning on sliver-to-yarn ring spinning frames

Rayon yarn production of "Aruncorder" frames

During a recent visit to Rochdale we were able to see the outcome of many of the improvements and re-equipment carried out to-date. It would not be possible to describe in any detail the new machines of many types which have already been installed but it is of interest to note some of the improved plant and the savings in production time and labour they have made possible. Two photographs we reproduce show the typical working conditions which now appertain and the arrangement of plant to give ease of access which is essential for efficient operation of textile machinery. New equipment and re-arrangements in the blowing room, where cotton bales are opened and foreign matter removed, have made possible improved blending. The laps, cylindrical rolls of loosely adhering cotton fibres, are now removed from the cleaning machines without stopping production as previously and the laps are double the weight hitherto made. In the carding room to which the laps are delivered and the remaining trash and short fibres removed the plant has been reconditioned and improved conditioning equipment installed to ensure a dust-free atmosphere. The long continuous slivers into which the cotton is converted on the carding machines are now coiled into cylindrical cans of three times the capacity of those previously used to transfer the product to the drawframes where this use of larger cans has resulted in longer runs and higher productivity.

In the next stage of processing, direct sliver spinning machines which have been installed in a single pass do the work which, in conventional practice, is done in three successive operations on what are known as slubbing, intermediate and moving frames. These direct sliver spinning machines were developed in the Dunlop plant in conjunction with Tweedales and Smalley Ltd., and the new lines installed at Rochdale can be seen in the illustration on this page. A four-fold increase in production has also been effected in a subsequent operation of doubling by the introduction of "two-for-one" twisting on a new design of machine.

Two new designs of high-speed machines are now being used for winding loom warp and the automatic winding of the weft yarns on pirns, or bobbins, for delivery to the looms, forty-six new automatic looms to be installed will be equipped with their own pirn winding attachments. For the weaving section there has been adopted a general policy for the replacement of the older Lancashire type of loom by modern automatic looms. In addition to the forty-six automatic looms order as mentioned above, other types of machine are undergoing tests for a variety of cloth production with a view to increasing the diversification of the firms products.

In the section of the factory concerned with the preparation of the rayon yarn used for tyre cord manufacture a valuable saving in labour costs and floor space has been effected by the introduction of "Aruncorder" machines. Rayon yarn delivered on bobbins to this section is processed by being twisted first in one direction, then doubled up with another twisted yarn and the combination twisted in the other direction. These two twisting operations, previously carried out on separate machines, are now carried out on a single machine having a spindle speed of 4750 r.p.m. The whole floor of new machines, shown in our second illustration, is now served by only two or three operatives to whom immediate indication of a broken yarn or full bobbin at any station is given by the illumination of a red light on the end stand of the machine.

Each stage in this plant modernisation and replacement programme has been carried out side-by-side with improvements in mechanical handling methods, standards of illumination, atmosphere conditions and labour amenities to ensure that the new equipment is well served to enable its efficient operation.

Heavy Pressure Vessel Welding Shop

DURING the past five years more than £2,000,000 has been spent on new workshops and equipment by Whessoe Ltd., of Darlington, and a new welding shop opened officially last week by Mr. F. Erroll, the President of the Board of Trade, marked a further step in the overall modernisation and re-equipment programme of the company.

One end of new welding shop for heavy pressure vessels

This new welding shop has been built and equipped at a cost of about £500,000 for the manufacture of heavy pressure vessels, a class of work in which the company has long specialised. The additional facilities provided by the shop have, it is believed, increased this country's capacity for manufacturing vessels of 100 tons and over by about 10 per cent. In providing this additional capacity Whessoe Ltd. has kept in mind the fact that in the not too distant future developing countries overseas may install their own facilities for pressure vessel manufacture. This has in no way deterred the firm from the project as it is considered that the highly specialised knowledge acquired over many years, and the exceptional facilities available, will ensure full use of the capacity in making pressure vessels departing from conventional designs and those for very high pressures, for which there will be an increasing demand. With the placing of the new shop in service one of the shops previously used for pressure vessel manufacture has been allocated solely to the production of heat exchangers for petroleum and chemical process plant, for which additional capacity was needed.

The new shop, the interior of which can be seen in the accompanying illustration, is 550ft long by 86ft wide with a height of 54ft to the roof ridge and 30ft to the overhead crane rails. It is a steel frame structure with aluminium sheet clad walls and an asbestos tiled roof. The walls incorporate a glazed area of 60,000 square feet to give a high standard of natural lighting over all parts of the working area. The full area of the shop is served by two overhead travelling cranes which have a combined lifting capacity of 125 tons, and there is a 10-ton hoist at one end for unloading a side intake bogie which is used to bring materials in from a storage area along one side of the shop. A matrix of flat topped steel sections cast into the concrete floor covers a large area, and rails along the length of this to handle vessels weighing up to 50 tons and, when required, two or more sets of rotators can be coupled together for heavier work.

The matrix carry mobile column and boom mounted welding heads. This matrix is designed to provide a means whereby the heavy work manipulators and rotators, used extensively in production, can be sited in any convenient position to the welding equipment. Rotators have been provided

A stress relieving furnace, believed to be the largest of its kind in Europe, has been built into one end of the shop. It is 85ft long, 18ft wide and 18ft high to the spring of the arch, and its bogie, which has a total load capacity of 200 tons, will carry 100 tons over a third of its length. The furnace is heated by town gas and has a temperature range of 400 deg. Cent. to 1150 deg. Cent. with fully floating control. A 100ft long compound along the side of this furnace has been specially designed for X-ray testing and to give full radiation protection for a 1,000,000V X-ray source. At present the compound is equipped with a mobile 400kV equipment and two bogies installed can together handle and rotate vessels of up to 100 tons. A series of rooms along the side of the compound have been set aside for the furnace control equipment, a dark room and metallurgical laboratories.

The new shop was built by Bovis Ltd. and the stages in construction were such that welding work was started before installation of the stress relieving furnace was completed. It is of interest to note that the early delivery and erection of the carriages of the two overhead cranes enabled them to be used in the construction of the roof. By this use of the carriages as a travelling scaffolding platform, which was moved as required along the shop by electric winches, much time was saved and the floor area was left clear for other work to proceed.

At the time of the opening of this new shop a number of large pressure vessels of interest were in course of construction. They included double skin liquid oxygen vessels for tonnage oxygen plants being supplied by the British Oxygen Engineering Ltd. These vessels comprise a 9ft diameter 27ft 9in long stainless steel vessel inside a 11ft 6in diameter 29ft 10in long outer vessel. The inner vessel is designed to work under high pressures and the annular space between the two vessels is filled with a heat insulating material and maintained under vacuum. For the Ministry of Aviation there were being fabricated 20in diameter by 6ft 2¾in high pressure vessels of $\frac{7}{8}$in thick stainless steel with spun ends. A stainless steel reactor vessel for Monsanto Chemicals Ltd. in $\frac{5}{8}$in thickness material was 11ft internal diameter and 5ft 9in high between tangents. Amongst several vessels for the Blaw Knox Chemical Engineering Company Ltd. were 4ft 9½in diameter spherical storage tanks for propane and storage vessels for hydrogen 7ft 6in diameter, 22ft long between tangents with 1 $\frac{13}{16}$in shell plates.

60-ton gas storage vessel in stress relieving furnace

Instrument and Machine Tool Exhibition

A JOINT exhibition of metrological instruments and machine tools by Taylor, Taylor and Hobson Division of Rank Precision Industries Ltd. and Société Genevoise Ltd., opened at Mayfairia Rooms, Bryanston Street, London, W.1, on November 9 and closes to-day, November 17. Foremost among the exhibits must be reckoned the SGIP "Trioptic", a development of the Mu. 214B universal measuring machine (Fig. 1).

Equipped with stabilised precision steel scales, the "Trioptic" is a three coordinate universal measuring machine, specially designed for convenience of operation—the operator can remain seated while working—and capable of taking a maximum work load of 150 kg. The coefficient of thermal expansion of the scales is practically the same as that of the machine itself and of the cast iron and steel parts most frequently measured, so that corrections for temperature are avoided.

The longitudinal and transverse travels for which either a hand feed or infinitely variable power feeds can be used, amounts to 400mm by 200mm, while the hand-operated vertical travel is 200mm. A single microscope with spring-loaded feeler is used for vertical, horizontal,

Fig. 1—"Trioptic" three-coordinate universal measuring machine

and thread measurements. By using feelers of appropriate shape as necessary, the following measurements can be carried out: length measurements in the direction of the three coordinates; centre distances of holes; angles and polar coordinates; internal and external diameters; concentricity; internal and external tapers; outside, effective and core diameters, linear pitch, progressive and periodic pitch errors, and profile angle of external threads; linear and effective diameter of internal threads; profiles of various shapes, &c.

The feeler is located on its holder by spring tension; thus it is deflected by a solid obstacle and accidental damage is avoided. With the microscope raised by inserting special blocks, maximum clearance between it and the table is 355mm.

Readings are taken in terms of the displacement of the steel scales which are incorporated in the moving members, relative to datum points defined by means of fixed optical projection systems. Vertical parallel errors are automatically corrected. Both horizontal coordinates are provided with zero-setting devices. Readings can be made to 0·5 micron and estimated down to 0·1 micron, while the guaranteed accuracy over a measured length of, say, 200mm, is ±1·5 micron.

The bed and the 600mm by 320mm longitudinal carriage are very stiffly supported: the vee and flat guideways are sufficiently long so that there is no overhang of any of the moving parts. In order to reduce slide friction, about 80 per cent of the moving masses are supported on rollers.

Accessories include a 300mm diameter circular table giving angular readings on a projection screen to one second of arc but guaranteed to within six seconds of arc; an electronic micro-indicator reading to 0·2 micron; a goniometric microscope reading to one minute of arc; profile heads for the optical gauging of thread contours; a dividing head reading to ten seconds of arc; and attachments for measuring between anvils, and for end measurements.

Taylor, Taylor and Hobson showed the latest version of the "Talyrond" roundness measuring instrument, the "Model 2," of which the worktable can carry components weighing up to 1000 lb. Shafts up to 50in long can be set up using a central aperture in the table which normally is covered by a plate. In order to allow heavy test pieces to be set up with the use of overhead hoists, the complete column and head assembly can be swung out of the way by rotating it through 90 deg.

A full range of "Talysurf" surface measuring equipment included the prototype 4in "Talylin" straightness measuring instrument. This gives an assessment of form errors of nominally straight lines on components. It employs an electric pick-up similar to that of the "Talysurf" in conjunction with the "Model 3 Talysurf" stand, amplifier and recorder. The basic difference in the new machine is that the guide shoe is in contact not with the component but with an optically flat glass plate, so that at each point the difference between the testpiece and a datum formed by the glass plate is recorded. The tip of the stylus is usually a hatchet shape with 0·25mm radius. Used in conjunction with suitable transverse speeds (152mm, 61mm and 30mm per minute), the instrument renders possible a study of the lower frequency surface errors without their being masked by the finer irregularities (for which the standard "Talysurf" is intended). Horizontal magnification with a rectilinear recorder is ×2, ×5, and ×10, while the magnification of the stylus movement at right angles to the test surface can take any of six values in the range ×200 to ×10,000. Accuracy is stated to be within 0·25 microns of a mean straight line over 100mm (4in).

An attachment shown as a prototype enables round shapes to be tested. The problem hitherto has been to guide the stylus in a path of the same curvature as the nominal curvature of the testpiece. The attachment uses a guide surface in the form of a convex (or concave) cylinder of 2in radius. By slewing the cylinder, the angle at which the plane in which the stylus moves intersects the axis of the cylinder can be varied between 90 deg. and 0 deg., thus giving effective guide "radii" from ±2in to infinity.

Another prototype was a mechanical pen for the speedy and accurate drawing of instrument scales. Fig. 2 shows the pen being used on a Taylor, Taylor and Hobson "Model D" engraving machine. It comprises a quill with a plunger, the weight of which is counterbalanced by a coil spring. Inserted in the plunger is a cartridge carrying a stencilling pen. In order to enable accuracy to be maintained when pens are interchanged for others of the same or a different size, each cartridge had to be provided with an accurate and closely co-axial hole for the pen. Not more than 0·001in error, it is claimed, results between any two graduations of the scale. The unit is mounted on an engraving machine in place of the cutter spindle and fed down to the scale to be marked by means of the screw or lever feed. It can be used either by employing a master copy of the scale face, or by picking previously scribed calibration markings.

Fig. 2 — Mechanical pen used on engraving machine

Technical Reports

Toroidal Discharge Configurations Obtained From Magnetic Probe Measurements (C.L.M.-R7). By E. A. Witalis, U.K. Atomic Energy Authority, H.M. Stationery Office. Price 7s.—Low pressure argon discharges in the Mk IV torus have been studied by magnetic probe technique during the early part of the discharge when the results so given are reproducible. A method of analysis is presented here by which the experimental results may be compared with those predicted by two theoretical models. It is shown that neither model is wholly satisfactory in this case. Several types of discharge are found, one of which corresponds to a "rigid" behaviour of the current helix which occurs just before the onset of irreproducibility of the magnetic probe signals.

Controlled-Potential Coulometry in Metallurgical Analysis (A.E.R.E.-R3772). By G. W. C. Milner and J. W. Edwards. U.K. Atomic Energy Authority. H.M. Stationery Office. Price 5s.—The suitability of controlled-potential coulometry for problems in metallurgical analysis has been investigated. Details are given of some analytical applications of a new coulometer developed at A.E.R.E., and the principles of the instrument and the technique are discussed. This technique has been used for the accurate determination of plutonium, mainly in binary alloys with uranium covering the range from 0·1 to about 12 per cent plutonium. Details are given of a coulometer cell which uses an ion exchange membrane to separate the main compartment from the auxiliary and reference-electrode compartments.

SHORTER REPORTS

Strand Underpass

At the meeting of the L.C.C. last Tuesday, the County Roads Committee gave details of the proposed Strand underpass. The consulting engineers, Messrs. Frederick S. Snow and Partners, had previously reported to the Committee on alterations to the disused Kingsway tramway tunnel to make part of it suitable for use by traffic between Waterloo Bridge and Kingsway. It is proposed to provide ramps to the surface in Lancaster Place and in Kingsway opposite Portugal Street and to use the old tunnel between these points. The tunnel will be 12ft 6in high with a carriageway of 17ft, slightly wider at the bends, with two verges of 1ft 6in each. It would normally be used for north-bound traffic only, but, if necessary, could be used in the other direction or for two-way traffic.

The side walls of the approach ramps will have a dark non-reflective surface, possibly slate blocks ; the tunnel itself will have a false wall and ceiling of aluminium treated to avoid confusing reflections and will also be backed or lined to keep down noise. The road will be of hot-rolled asphalt, giving a dark appearance " to contrast with the walls " and ceiling. There will be a central broken line and the kerb will also be painted white.

Lighting will be by two continuous rows of shielded fluorescent tubes in the angles between the walls and the ceiling. The lighting at the south end will be graded to minimise the contrast between natural and artificial light. This should not be necessary at the northern end but it would be a simple matter to install it if it were later found desirable.

The consulting engineers suggested, for safety reasons, that a louvred canopy should be provided over the southern approach ramp to the tunnel in Lancaster Place to help grade the contrast between daylight and artificial light and to cut out the direct rays of the sun shining down the tunnel entrance, but the Committee has decided not to include this because it would be unsuitable to the area architecturally and as traffic will normally use the tunnel from south to north, the problem of dazzle from the sun's rays is unlikely to arise very frequently if at all. It will be necessary, however, to achieve light gradation wholly by artificial light, so that although £10,000 will be saved by omitting the canopy, there will be an increase of £9000 in the capital cost of lighting and additional annual lighting costs of about £1400.

The limitations imposed by the width and height of the tunnel and the gradient of approaches will make it necessary to restrict its use to vehicles of limited size rather than weight, and will probably necessitate some form of automatic light ray detection and warning system for high vehicles.

Work should start in April next year. The estimated cost, excluding the canopy, is £797,800.

The Development of Equipment for The Royal Engineers

On November 9 the Institution of Structural Engineers held its first joint meeting with the Institution of Royal Engineers to discuss a paper on " The Development of Engineer Equipment for the Army," presented by Brigadier H. A. T. Jarrett-Kerr, O.B.E., B.A., Deputy Director of the Military Engineering Experimental Establishment. The President of the I.S.E., Mr. F. R. Bullen, took the chair and extended a warm welcome to the Royal Engineers present, particularly to their President, Major-General Sir Douglas Campbell, and President-elect, Major-General D. C. T. Swan, who was to assume office the next day.

The paper had been published in the September issue of the *R.E. Journal*. Brigadier Jarrett-Kerr introduced it with coloured slides of many of the equipments mentioned in the script, and a wide-ranging discussion ensued, enlivened by certain reminiscences from Structural members who had served in the Sappers. The key note was struck by the member who wished the modern equipment had been available to him in the Corps in 1940 ; it was beyond dispute that excellent progress had been made.

The special considerations that apply to military equipment as compared with a civilian, commercial counterpart were emphasised in the paper ; they derive chiefly from the greater need for speed, lightness, and simplicity. Further factors came out in the discussion. The new, Twynham hut, replacing the Nissen and others, was criticised for comprising bays no larger than 8ft ; but, it was pointed out, the hut was for world-wide use and would have to withstand extreme snow and wind loadings : a small bay meant a small bay loading and consequent ease of site preparation on poor soils.

In contrast the sway bracing of the war time Bailey bridge was criticised as inadequate for certain of the multifarious uses to which contractors have since put this equipment. The suggestion that military equipment should be designed with an eye to its post-war use, after passing through the second-hand market, provoked—as was perhaps intended—a host of tributes to the Bailey bridge ; one speaker had found 250 uses for it! The meeting was assured that all the well-proven principles of the Bailey had been incorporated in its successor, the heavy girder bridge.

A degree of mistrust over an increasing dependence on hydraulic equipment became evident during the discussion, and the eight-year period of gestation for new equipment repeatedly came under fire. Spokesmen conceded that hydraulics had their disadvantages, particularly when the equipment had to be stored for a long time ready for use, but there was no concession over the eight years for a peace time development. The process was no faster in other countries or, indeed, in the comparable commercial field ; army trials took up fully half of the time. Satisfactory development demands the patience of all concerned.

Post Office Telecommunications

In the Post Office Report and Commercial Accounts, 1960–61 (Cmnd. 1521, H.M. Stationery Office, price 5s. 6d.) it is shown that inland telegrams during the year numbered 13,567,000, a decrease of 260,000 (or 1·9 per cent) on 1959–60. Greetings telegrams made up about a quarter of the total. The number of overseas telegrams also declined slightly, by 362,000 to 20,022,000. Ship-shore telegrams (839,000) fell by 1·6 per cent. Telex traffic, however, continued to rise. Completion of the conversion of the inland Telex system to automatic working resulted in the number of dialled calls rising by 2·6 million. The total number of calls (5·3 million) increased by 24 per cent. At the end of March the number of subscribers to the Telex services was 7089, an increase during the year of 20 per cent. Ten new automatic Telex exchanges were opened. By the end of the year Telex services were available to fifty-three Commonwealth and foreign countries.

The number of exchange connections to telephones rose during the year above 5,000,000, and by the end of the year there were 8,280,000 telephones—more than in any country in the world except the United States. The supply, at 477,000 connections, was a record, but at the end of the year 170,000 orders were on hand, although 115,000 were already being met or in course of enquiry. The remaining 55,000 could not be met immediately because no wires were available in underground cables, or the exchanges concerned were already working to capacity. The Subscriber Trunk Dialling Service was considerably extended. Installations serving fifty-seven exchanges, with 192,000 lines, were brought into service. Mechanisation of the overseas telephone services continued, enabling London operators to dial to subscribers in Austria, Belgium, Denmark, Germany, the Netherlands, Sweden and Switzerland.

Computers and Production Control

For the past two years a sub-committee of the Research and Technical Committee of the Institution of Production Engineers has been investigating the possibilities of applying computers to production control in the manufacturing industries. The report on this investigation has now been published under the title " Computers and Production Control," and is available from the Publications Department, Institution of Production Engineers, 10, Chesterfield Street, Mayfair, London, W.1, price 7s. 6d. post free. In six sections and an appendix the report includes a description of the various types of computer ; a definition of production control, with observations on the use of computers in such systems ; an economic assessment ; conclusions ; and illustrative case studies. Section 2, " Computers," defines the terms used in computer technology and will assist prospective users over their first hurdle—that of reading computer specifications with some degree of comprehension. It is admitted in the section on economic assessment that such assessments are extremely difficult because of the intangible factors involved along with the tangible, and the two essential foundations for beginning a computer project are stated to be its management by someone of considerable ability, and the prospect of sustained managerial support. In its conclusions the sub-committee suggests an approach by stages, beginning with the clear definition of objectives, and proceeding to the evolution of a set of rules for achieving them. The next stage is to select a data processing system for applying these rules in a routine manner to the problem of production control. If the production control problems are complex, the volume of data is high, or the processing must be done within a tight time schedule, a computer may be the appropriate tool. Hiring computer time may be a practical approach for a small company, while even for a large one this method may be desirable until a sufficient volume of work has built up to justify the purchase of an installation.

The sub-committee cannot recommend unconditionally the use of a computer for process control, although it considers that the studies undertaken on lines suggested in its report for deciding whether a computer can be justified are likely to be beneficial in themselves, whatever the final decision may be. The four case studies forming the appendix to the report describe actual computer installations and procedures adopted for sales scheduling, textile production, electronic equipment production, and the manufacture of computers themselves.

Hyde Park Underground Garage

The Westminster City Council has been given Government authorisation to begin work on the Hyde Park underground garage near Speaker's Corner. Powers to make a site available for this purpose were given in the Hyde Park (Underground Parking) Act, 1961, which received the Royal Assent on June 22. The garage will be built by Sir Robert McAlpine and Sons Ltd. at a cost of rather over £1,000,000. It will be on one floor and will hold between 1000 and 1100 cars. Vehicles will enter and leave by ramps from the northbound Park Lane carriageway and from the North Carriage Drive in Hyde Park, near the Cumberland Gates. Pedestrian access will include an underground connection with Marble Arch tube station. Excavation should begin within the next few weeks. The work is scheduled to take sixty weeks.

Induction Motors with Speed Change by Pole-Amplitude Modulation

TWO-SPEED, single-winding, squirrel-cage induction motors, with speed changing by pole-amplitude modulation, were demonstrated recently to C.E.G.B. engineers and consulting engineers on a visit to the Trafford Park works of Lancashire Dynamo and Crypto Ltd., a company in the Metals Industries Group.

Speed changing by pole-amplitude modulation was invented by Professor G. H. Rawcliffe, Pro.e.sor of Electrical Engineering at Bristol University, and has been developed in collaboration with the National Research Development Corporation and a number of manufacturers of electrical motors. The flexibility inherent in this system of speed changing has considerably widened the applicability of the squirrel-cage induction motor—already the most universal of electric motor drives. Hitherto speed changing with a single winding has been limited in practice to the 2 : 1 speed ratio. Other speed ratios have required a two-winding stator (involving a large number of terminals and comparatively complicated control gear) which is not commercially attractive. With pole-amplitude modulation, on the other hand, the stator has a single winding; more effective use is made of the winding space and the frame size can be reduced ; there are only six winding leads and the control gear is relatively simple.

The principles of the system have been described elsewhere.* Briefly, pole-amplitude modulation of the stator winding is a concept analogous to amplitude modulation of an electromagnetic wave. Speed change is effected, as in the well-known 2 : 1 tapped winding, by reversal of part of the two-layer lattice winding with respect to the rest of it. The main difference is that on the 2 : 1 tapped winding alternate pole groups are reversed for pole changing ; with pole-amplitude modulation selected halves of the phase windings are reversed, with special groupings of the coils and, in some cases, the omission of certain coils to improve the magnetomotive force pattern.

There are two alternative winding connections. In one, the winding is arranged " star/two-parallels " for the high speed and " series/star," with some coils omitted, for the low speed. In the other scheme the winding is connected " star/two-parallels " for the high speed and " series/delta " for the low speed. For both methods of connection the controller can be similar to the 2 : 1 tapped winding starter—that is, one three-pole and one five-pole contactor or the equivalent. These two methods of connections provide different motor characteristics and the choice between them usually depends on the speed torque characteristics of the load. In the first method the motor rating at the high speed is the same as that of a similar single-speed motor ; at low speed, however, the power output is reduced to about three-quarters of the corresponding single-speed rating. This reduction would be tolerable for drives such as fans and pumps. In the second method the reduction in rating compared with the single-speed motor is about the same at both speeds and is of the order of 10 or 15 per cent. Such a characteristic would suit drives of constant horsepower.

Before these new windings were offered commercially they were the subject of an extensive experimental programme. In addition to pole ratios, the coil pitch, coil groupings and slotting ratios are important factors in the determining of the performance of pole amplitude motors. A programme of prototype tests was therefore carried out by Lancashire Dynamo and Crypto Ltd., in which windings, which had been designed from theoretical considerations and which had been tried on small machines at Bristol University, were applied to medium-sized machines in the 30 to 100 h.p. range.

In addition to all normal tests at both speeds, the noise level was measured on the loaded and unloaded machines and was found quite acceptable. Dynamic speed-torque characteristics were taken on a Dudell oscilloscope and the results indicated that there were no objectionable torque dips at either speed. It was also established that good agreement between design calculations and test results could be obtained.

Pole-amplitude modulation has been applied to speed ratios of 1 to 1·5 or closer and, more recently to wide speed ratios. Motors with a speed ratio of 1·5 : 1 or closer are frequently used for centrifugal fan and pump applications where the load varies as the cube of the speed. They are also occasionally used for constant torque loads, such as conveyors. Connections for both kinds of load are fully developed for 6/8 and 8/10 pole motors and for multiples of these pole numbers. At present the top limit for these motors has been fixed at a top speed output of 4000 b.h.p. The wide-speed-range windings are likely to prove useful for motors where inching or regenerative braking forms part of the duty.

Typical examples of some L.D.C. pole-amplitude modulated motors in use or under construction are given below :

1. Vertical pipe-ventilated 17 to 7·5 b.h.p. 16/20 poles, at 400V, 40 c/s, three-phase driv.ng cooling tower fans at 286 to 228 r.p.m. In this case the speed change is accomplished twice annually (to suit climatic conditions) by changing links in the terminal box. A normal, single speed squirrel cage starter is used.

2. Totally enclosed, " Corcooled " 336 to 148 b.h.p. 8/10 pole motors at 3300V, 50 c/s, three-phase, driving i.d. Fans having a WR^2 of 17,500 lb per square foot. The starting current is limited to 4·5 times full load current at both speeds.

3. Ventilated, weather-protected 840 to 450 b.h.p. 8/10 pole motors, 740/590 r.m.p. at 6000V, 50 c/s, three-phase, driving i.d. having a WR^2 of 100,000 lb per square foot.

As mentioned above, the motor speed can be changed by altering links in the motor terminal box or by an off-load changeover switch, so that a conventional single speed starter can be used for starting and stopping. Where automatic or remote control is required, a three-pole and a five-pole contactor, or an equivalent arrangement is needed.

On large high tension motors for power stations with large fault level capacities, circuit breakers are commonly employed for motor switching. As five-pole circuit breakers are not usually available, two three-pole and one two-pole breaker may have to be used. This is relatively expensive and could partially cancel out the saving in the motor price. A more economical method of control is the use of two three-pole circuit breakers with an interlocked, off-load contactor which makes the star point before the motor is connected to the supply by the high-speed circuit breaker. It opens the star point after the motor has been disconnected from the supply. As on all two-speed motors, where the number of poles differ by two there must be a time delay to ensure that the first field has died down before the motor is switched to the second speed.

In all cases where fully tested pole-amplitude modulated windings are available they will be offered by Lancashire Dynamo and Crypto provided their use results in the most economic arrangement coupled with adequate performance. This applies at present particularly to the 6/8 and 8/10 pole machines and to multiples of these pole numbers. Development work is in progress on the 4/6 and the 10/12 pole connections and also on wide ratio windings. As and when these new pole ratios have been proved satisfactory they will be added to the range of two-speed motors for which pole amplitude modulation can be supplied.

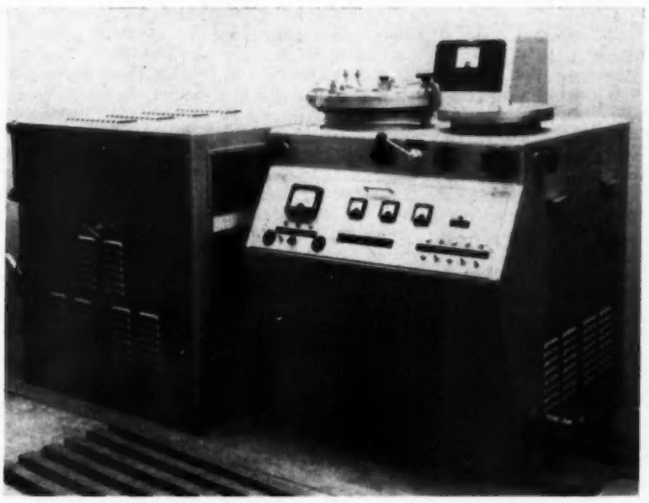
[Reply Card No. 1382]

* *A.E.I. Engineering*. Associated Electrical Industries Ltd. Vol. 1., No. 6, June, 1961.

Vacuum Sintering Furnaces

A HIGH vacuum sintering or heat treatment furnace, developed by Vacuum Metallurgical Developments Ltd., Alma Works, Manchester 19, is made in two models—one with manual and the other with automatic controls. With the manually controlled model the charge is loaded on a tiered tray assembly and placed in the chamber. The resistance heater is designed to give operating temperatures of up to 2400 deg. Cent. at pressures better than 10^{-3}mm/Hg.

The heating element, fabricated from " Tantalum " or tungsten sheet in three segments, forms a circle 3⅞in diameter by 15in long. Each segment is riveted to " Tantalum " or tungsten sheet conductors leading to connections on the bus bars and these connecting sheets, as well as acting as conductors, support the element. Radiation shields fabricated in segments form a complete enclosure around the element and the entire assembly is held by nuts, screws and spacers, thus eliminating the use of refractories. This element and radiation shield assembly is readily detachable from the chamber—to facilitate maintenance and cleaning, and the entire unit is enclosed in a steel cabinet finished in stove grey enamel.



Manually controlled vacuum sintering or heat treatment furnace

Transformers housed in a second cabinet supply power to the heating element, variation being provided by an auto-transformer controlled by a rotary switch or core reactor system. Safety interlocks protect the equipment against water failure and independent fuses to each main component are fitted.

The furnace which embodies semi-automatic controls has a multi-position rotary switch which ensures correct sequence and has overriding switches to enable any individual operation to be accomplished without the use of the sequence switch. A sequence switch is provided for the first stage of the operating cycle but the heating control can be slaved to the pressure instrumentation, to ensure long life of the rare metal elements and radiation shields, as well as allowing the plant to be operated by a semi-skilled operator. The outgassing rate is automatically controlled by presetting the pressure gauge at the required level, the rate of heating being then controlled so that the pressure never exceeds the gauge setting.

[Reply Card No. 1375]

SHORTER REPORTS *(Continued)*

Diesel Engineers and Users Association

AT the annual general meeting of the Diesel Engineers and Users Association, Mr. F. D. M. Gamble was installed as president by the retiring president, Mr. W. A. Parker, and Mr. J. S. Tritton and Mr. D. S. D. Williams were re-elected as honorary secretary and honorary treasurer respectively. The Percy Still medal for 1961 was awarded to Mr. J. Griffith, B.A., for his paper "Diesel Propulsion for Small Vessels." The Association also decided to apply the funds accumulated in the Akroyd Stuart Memorial fund to the annual award of an Akroyd Stuart medal to an author presenting a paper making a worthy contribution to oil, gas and dual fuel engines and gas turbine design and development.

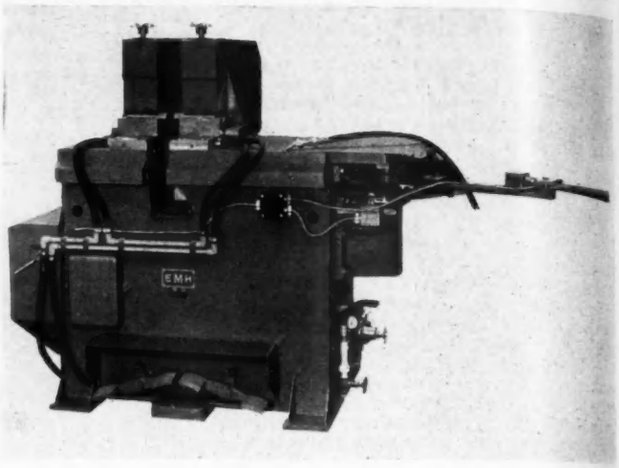
Single-Line Track Laying Machine

A PROTOTYPE single-line track layer in use on the Eastern Region of British Railways, can be operated without possession of an adjoining line. Known as the "Arki-Endon" equipment, it is similar to an appliance already used on the Continent, and it has been modified to make it suitable for use by the Eastern Region. By using this equipment to relay one line of a two-tracked route, single line working can be employed on the other, and it is stated that the machine also shows to advantage when relaying a single line. The machine consists of five power driven and self-propelled portal cranes, and it can be seen in operation in the illustrations below. Each of these portals is fitted with a lifting winch of three tons capacity.

The equipment travels to and from a relaying site on two "Sturgeon" wagons which have been specially modified for this purpose. In their travelling position to the relaying site the portals are carried in a sideways position and resting on their driving wheels on the wagon floors, an arrangement which keeps them within the rail load gauge. Upon arrival at site the portals are jacked up and supported on a second set of free wheels on rails laid to 4ft 8½in gauge along the wagon floors. They are moved in turn along these rails to one end of the wagons from which they run down a ramp on to a turntable which forms part of the equipment carried with the train. This turntable is used to turn the portals at right angles to the track and then, carried on their driving wheels, they are run down another ramp on to the guide or service rails upon which the appliance works.

The guide or service rails are formed from long-welded rails previously brought to the site and with which the track is to be later re-railed after the initial laying in of 60ft lengths of prefabricated track. When they are installed these 300ft long-welded rails are lifted from their train by a line of seven small portals and placed on special lifting and traversing jacks set at about 15ft centres. These guide rails are laid 6in above the level of the running rails and are held down by rail anchors spaced at 60ft intervals. When they are connected together with temporary fishplates, these guides or service rails then act as running rails for the tracklayer. At some future date when the welded track is to be laid in the 60ft rails are taken out and replaced by the 300ft service rails.

The track laying equipment is designed to lift a 15-ton load and can deal with 60ft lengths of concrete sleepered track having the maximum number of concrete sleepers required. The height of the portals enables the machine to deal with three tiers of concrete sleepered track or four tiers of timber sleepered track loaded on "Sturgeon" wagons.



Semi-automatic hand operated flash or butt welding machine

Hand-Operated Flash or Butt Welding Machine

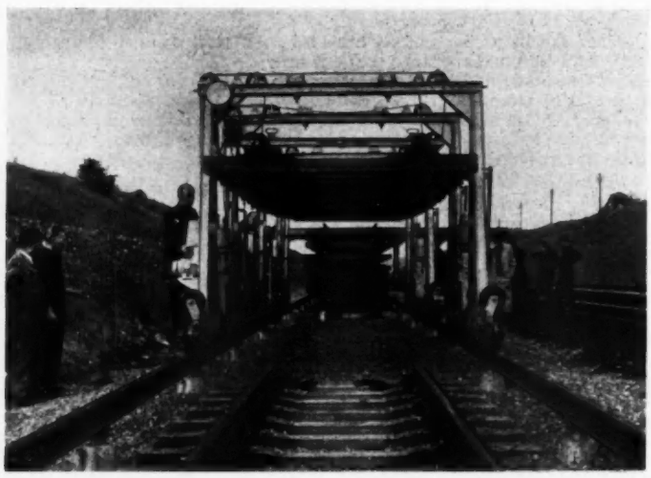
A SEMI-AUTOMATIC hand-operated flash or butt welder, made by Electro Mechan-Heat Ltd., Manor Works, Bilston, Staffordshire, has a nominal rating of 50kVA with a peak upsetting power of 90kVA. It is provided with a single phase 220V, or 400/440V 50 c/s, transformer having a water-cooled secondary with five primary tappings by use of which the power can be varied between 30kVA and 90kVA.

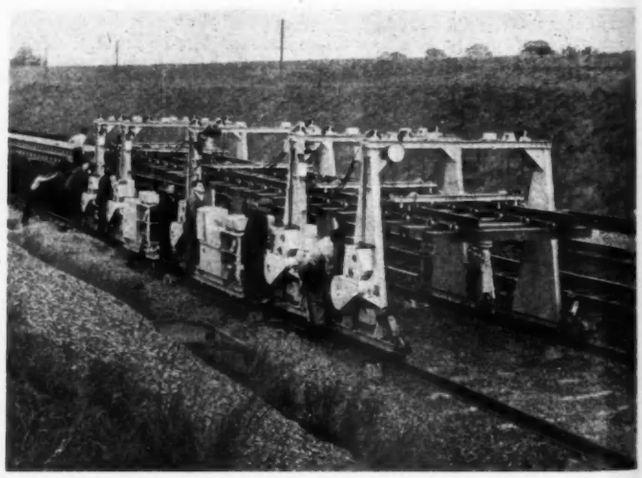
On this machine, illustrated above, tubes up to 1·55 square inches, flats up to 1·86 square inches and bars up to 2·48 square inches in cross sectional area can be welded. It is fitted with air operated vertical work clamps capable of exerting a pressure of approximately 3 tons with a cylinder air pressure of 71 lb per square inch. Jaws are operated through levers by the pistons of two 4in bore cylinders at the back of the machine under pedal control. The clearance between the water-cooled copper jaws of the clamps can be adjusted by hand screws over a distance of 2·36in.

The moving table of the machine is operated by a hand lever through a quadrant assembly and various rates of burn-off can be set on the quadrant, which is graduated in millimetres. Adjustments to a connecting arm at the base of the hand lever vary the upsetting pressure between 2 and 3 tons. Initial clearance between the two tables is adjustable between 0·57in and 4·7in.

The welding current is controlled through a heavy duty two-pole magnetic contactor, the current being initiated by a trigger on the traversing hand lever. In operation any number of pre-heating strokes can be made to bring the workpieces up to welding temperature. When the arm of the hand lever reaches the pre-setting pointer on the burn-off quadrant, the welding current is automatically cut off. A blow gun is provided for the removal of flash between welding operations.

[Reply Card No. 1372]





(Left) Track laying machine carrying length of concrete track from wagons to laying position. (Right) Single line track layer travelling with 60ft timber track for relaying

Long-Haul Terminal at London Airport

FROM November 13 the first part of the new long-haul terminal building at London (Heathrow) Airport has been in use for passenger departure by the services of B.O.A.C. and its associates, and of other companies handled by B.O.A.C. The building is divided at ground floor level, the half now in use including the departure ticketing hall. In the other half is the arrival Customs hall, which is due to be in service in the Spring of 1962, when the remaining companies still accommodated in the North Terminal will transfer their services to the new building. At the same time B.O.A.C. and associated arrivals will transfer to the building from No. 1 or No. 2 Passenger Building.

Basically the design of the terminal, known as No. 3 Passenger Building, consists of a 430ft by 280ft passenger building flanked by two 411ft by 55ft office blocks on either side of a rectangular forecourt. The southern office block is due for completion next Spring and will include the main public restaurant and bar of the terminal. Completion of the north office block is due early in 1963. The cost of the whole project will be between £2,500,000 and £3,000,000.

Central staircase from ticketing hall to departure lounge at London (Heathrow) Airport No. 3 Passenger Building, showing dome lights and fluorescent fittings in suspended ceiling

Passengers' luggage for departure flights is transferred from the land side of the building to the air side by underground conveyors, connecting with a transverse conveyor at the air side having an hydraulic arm system under push-button control for lifting baggage off the belt at specific collection points. Passengers proceed by a central staircase from the ticketing hall to the final departure lounge on the first floor, from which a gallery and ramps give access direct to aircraft or to coaches for the more distant aircraft stands. About two-thirds of the stands are reached by coach, and one-third are within walking distance. There will be walking access to further stands to be provided flanking the office blocks when the latter are completed. Passengers' friends may enter a gallery above that giving access to the aircraft, from which there is a view both into the departure lounge and over the aircraft stands.

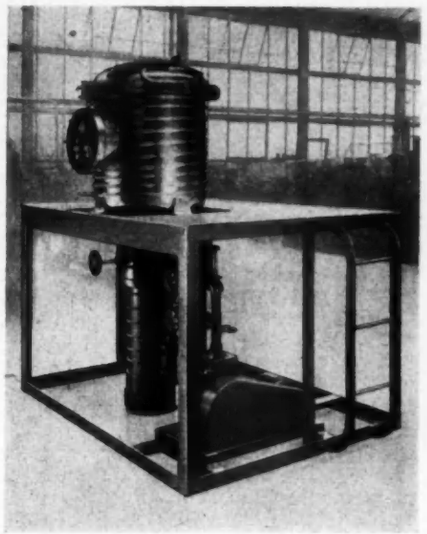
The main contractor for the passenger terminal building is Taylor Woodrow Construction, Ltd. It is a steel-framed building designed as a large, rectangular, two-storied box, with natural lighting provided by glazed walls and domed roof lights. Forced and filtered ventilation is provided on an inlet and extract basis from plant rooms on the roof. The building is sealed as a protection against external noise and fumes, and there is provision for double-glazing of the exterior surfaces which face aircraft stands. Externally the roof is of light waterproofed metal decking ; the roof steel, and the services housed within the structure, are concealed by a suspended ceiling of fibrous plaster. Within the roof are set the 260 dome lights. Fluorescent lighting fittings, recessed into the ceiling between the domes, as seen in the above illustration, are arranged to hinge upwards for servicing and relamping from above. " Perspex " covers enclose the tubes, but no louvres are fitted because the recessing prevents glare from nearby fittings, while giving the whole ceiling a uniformly light appearance derived from the numerous light sources. The architect for the whole project is Mr. Frederick Gibberd, C.B.E., A.R.A., F.R.I.B.A., M.T.P.I., F.I.L.A.; consulting engineers are Sir William Halcrow and Partners, in association with G. H. Buckle and Partners for the heating, ventilating and electrical services ; and the quantity surveyors are Franklin and Andrews.

Public address equipment was supplied by The General Electric Company Ltd., and installed by The Reliance Telephone Company, Ltd. The main system comprises two 175W amplifiers (one as standby) with facilities for connecting up to twenty-three microphones from which announcements to passengers can be made by the various airlines. At each microphone position a red light comes on if the " speak " key is operated while the system is engaged, but the announcer is notified by buzzer when it becomes free. Five seconds are then allowed for switching in again to make an announcement, and if this is not done a similar signal is given at the next microphone position waiting to speak. Two 50W systems and a 30W system, also with standby facilities, are being supplied for other authorities and services in the building, and priority arrangements enable Ministry of Aviation announcements to be made on all loudspeakers and to override all others. The suspended group of loudspeakers in the main hall consists of four line source units, each containing five individual speakers. Sound distribution is planned for uniformity of volume in all parts of the hall, avoiding excessive levels near the loudspeakers themselves. In other parts of the building loudspeakers are fitted above ceiling grilles.

Vacuum Brazing Furnace

AN electrically-heated, cold retort furnace specially designed for brazing components in vacuum, introduced by Royce Electric Furnaces Ltd., Sheerwater, Woking, Surrey, is illustrated here. This furnace is fitted with a molybdenum wire element providing temperatures up to 1200 deg. C., and with it operating vacua down to 10^{-5}mm mercury can be obtained.

The furnace chamber—a water-cooled, heavy-gauge steel cylinder—is domed at the bottom and has a removable domed cover to give access to the interior. It is mounted on a floor-standing framework fitted with a substantial top plate to provide a platform for the operator. In the furnace chamber there is provided a work space 8in in diameter and 8in high, and the charge is placed on a support made up of molybdenum rods with alumina top covers. The element is surrounded by radiation screens of " Nilo K " with an inner screen of molybdenum. Screens are assembled with molybdenum tubes and spacers and are housed in a steel canister supported within the chamber. Another assembly of radiation screens of the same materials provides a removable top cover. The element operates at a low voltage supplied by a variable voltage regulator transformer.



Vacuum brazing furnace with an 8in diameter 8in high working space. Working temperatures up to 1200 deg. Cent. are available and vacua down to 10^{-5}mm Hg can be obtained

Temperatures are controlled automatically with reference to a two-point recorder housed in a wall mounting panel and leads to the thermocouples can be taken through the molybdenum tubes in the radiation screen assembly without disturbing the whole assembly. The furnace is supplied as a unit complete with control gear and an Edwards " Speedivac " pumping equipment which is mounted beneath the operator's platform.

[Reply Card No. 1373]

Control System Sub-Assemblies

FIVE units have been added to the range of " Norbit " electronic sub-assemblies for industrial control systems made by Mullard Equipment Ltd., Mullard House, Torrington Place, London, W.C.1. The original series was described in THE ENGINEER of November 20, 1959, page 658. Experience has shown that existing " nor " units are often used with only one or two of their inputs connected, and one of the devices now introduced is therefore a " Double Norbit " (YL6012) consisting of two two-input elements built into a single standard case. Cross-coupling of these elements provides a convenient method of producing a memory circuit.

Two new output units comprise one of medium power (YL6008) which may be driven by a " Norbit " emitter follower, and a low-power unit (YL6009) for lamp or relay operation, replacing the previous separate units for those functions, and not requiring external emitter-follower drive.

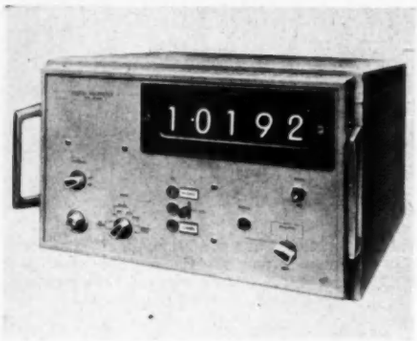
Two further units comprise a photo-head (YL60101) and lamp unit (YL6011) for using " Norbit " systems with a photo-electric input. Both units are dustproof and splashproof, and particularly suitable for all kinds of batch-counting applications. An addition has also been made to the range of power supply sub-assemblies in the form of a regulated unit (YL6105) providing 100mA at 6V with variation of output not exceeding 0·2V for a mains change of ±15 per cent, or variation of load from full to half, or from half to no-load. This has been designed primarily for use with the " Combi-element " circuit blocks which were also described in the issue referred to above.

[Reply Card No. 1368]

SHORTER REPORTS *(Continued)*

Digital Voltmeter

SILENT operation by the use of transistors for reference resistor switching in the analogue/digital conversion process is one of the features of the LM1010 digital d.c. voltmeter of Solartron Laboratory Instruments Ltd., Cox Lane, Chessington, Surrey. The voltage coverage from 20μV to 1·5999kV is divided into five manually-switched ranges, and two additional ranges have scaling suitable for giving direct temperature readings from vion/constantan or chromel/alumel thermocouple units. Input impedances on these two ranges, and on the two most sensitive voltage ranges, are sufficient for using the capacitance transfer method in the measurement of the true d.c. level of a direct voltage carrying



Voltmeter providing simultaneous digital indication and print-out signals

a superimposed a.c. component. In this method a capacitor is charged to the level of the unknown voltage and then connected across the voltmeter input either manually or by a chopper relay.

The voltmeter can be switched for manual or "auto" operation. In the manual mode a single input sample is taken by pressing a panel push-button. On "auto" the input is sampled at mains frequency. A Weston standard cell is fitted for precise calibration of reference supplies and zener diodes are temperature-controlled to maintain accurate operation. The five-figure digital display is by optical projection with red or black backgrounds to indicate positive or negative inputs respectively. Decimal outputs at −12V d.c. are extended to a seventy-five-way rear-mounted socket for driving an in-line printer or remote digital display. Overall dimensions are 10in by 18in by 16in and the weight is 50 lb.

[Reply Card No. 1361]

Large Automata Clock

AN automata clock which has just been placed in service on the Fraser Building in Edinburgh provides an excellent example of hand craftsmanship combined with modern precision time-keeping and sound-producing equipment. This clock, 11ft 6in high with 3ft diameter dials and weighing over 1 ton, was designed, built and erected by the Synchronome Company Ltd., of Alperton, Middx. It projects some 8ft from the wall of the building and represents in miniature a part of a castle complete with entrances and portcullis. Flying buttresses support the clock chamber below which there is a circular track round which a procession of four pipers and a pipe major parade at each quarter chime. The sides and all the exterior parts of the clock are of non-ferrous metal beaten to represent conventional ancient castle walls and painted to represent weathered stone, whilst pipers of beaten copper and clad in the Fraser tartan are true-to-scale in every respect. The clock sounds the Westminster quarter chimes and strikes the hours; at 7½ minutes past the hour there is played on "bells" the tune of "Scotland the Brave" and at 37½ minutes past the hour "Caller Herrin."

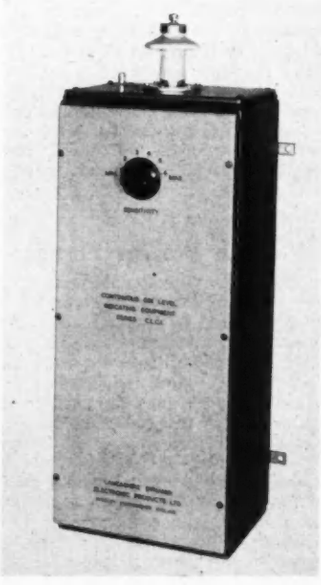
The clock itself contains no timing mechanism, the actual movement of the hands and chiming being remotely controlled by a Synchronome master clock. This master clock is independent of mains power supply, and it transmits electrical impulses every half minute to the hands of the main clock. These impulses also actuate the mechanism which controls the times of striking and chiming and the driving equipment for the procession of pipers.

The chiming system has a twenty-five note compass, the equivalent of about 10 tons of heavy bells, and equipment has been installed to produce these tones electrically without the use of bells, records, tapes or microphones. In this equipment the actual tones are produced by charging an electrical capacitor and the system lends itself readily to the control of attack and decay of each tone. Speed of die-away of each component "bell" tone is separately adjustable and the design of the equipment is such that there are no mechanical components to wear or deteriorate. The output from the tone generating units is taken through conventional amplifiers and then transmitted to the sound producers. A keyboard included with the equipment permits the "bells" to be played by hand within the compass of the twenty-five notes. A selector switch enables the automatic tunes provided to be cut out when desired, and the chimes as well as the automatic tunes can be silenced for a pre-determined period at night.

Bin Level Indication

CONTINUOUS local or remote indication of the level of the contents of storage bins is provided by the "Quantimeter" equipment announced by Lancashire Dynamo Electronic Products Ltd., Rugeley, Staffs. Levels are sensed by the changing capacitance between a wire probe and the container walls as the material builds up along the length of the probe. This change is reflected in the gain of an amplifier, the output of which is applied to an indicator or recorder. Full-scale deflection can be adjusted to six ranges of capacitance change by means of the rotary switch on the front panel of the measurement unit illustrated. Allowance is made for materials of different dielectric constants by a pre-set full-scale control, the settings of which for various substances may be noted and reproduced as required.

The sensing probe assembly consists of a tensioned wire running between insulators at the top and bottom of the container. Bifurcated



Measurement unit of capacitance system for indicating levels of materials in containers

probes are supplied to meet the requirements of containers with divided inlet or output chutes. While the main control unit should be mounted as close to the probe as possible, the distance between the measurement unit and the indicator may be as much as 1000 yards.

A phase-sensitive rectifying circuit in the amplifier eliminates the effect on the measurement unit output of changes in probe-to-bin resistance such as might arise from variations of conductivity due to moisture in the material being measured. The unit illustrated contains the capacitance measuring circuits and power supply on a removable interior chassis.

[Reply Card No. 1359]

I.C.E. Lecture Theatre

THE lecture theatre at the Institution of Civil Engineers has been remodelled, and in its new form was inaugurated last week when Sir George McNaughton delivered his presidential address. It now contains the latest sound and projection equipment and has completely new seating and lighting arrangements. Accommodation is provided for 284 on seats which tip up. The position of the Chairman's platform has been changed, and the floor from the centre of the room to the rear has been raked.

The Council decided, in October 1960, that the lecture theatre, which was built in 1912 when the main building was erected, should be modernised. All types of slides can now be shown on a projector equipped with xenon lighting; the 16mm film projector can take both optical and magnetic sound tracks. Furthermore, the speaker will be able to explain points on an electrical blackboard. Following the successful trial of closed-circuit television at the Graham Clark Lecture which was delivered by H.R.H. Prince Philip, the lecture theatre has been connected with the Great Hall and the Brunel Room for overflow audiences.

The portrait of Thomas Telford, the first President, has been placed behind the chairman's chair in the new theatre: Telford began the regular Tuesday-night discussions which have been continued through the years. Also in the lecture theatre are the portraits of the first twenty-five Presidents.

The architects were Robert Atkinson and Partners and the building contractor F. C. Hoskins and Co. Ltd. The G. B. Kalee Division of Rank Precision Industries Ltd. supplied the projection and sound equipment and the seating; Troughton and Young Ltd. were responsible for the installation and electrical work.

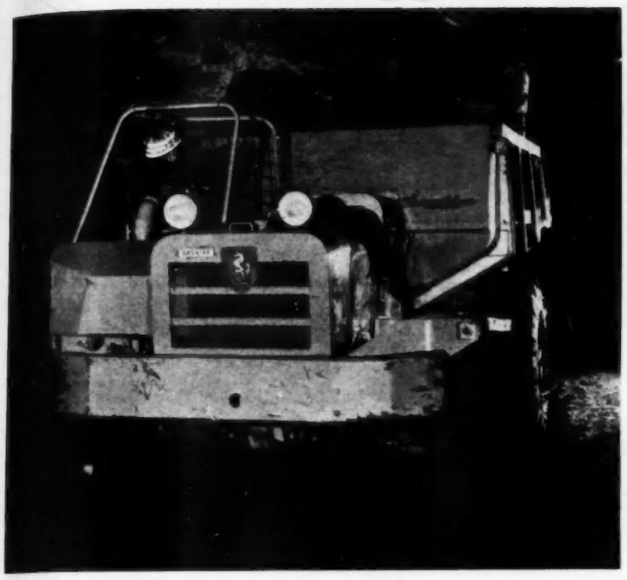
Changes in B.S.I. Structure

HITHERTO, the British Standards Institution's technical work has been handled internally within five sections. Now, the number of sections is to be increased to seven. The two new ones will be concerned with metallurgical and some engineering industries, and safety and consumer standards. Codes of practice work is now to be combined with building activities.

Mr. Gordon Weston, B.S.I.'s technical director, has been appointed associate director of the Institution. Dr. H. M. Glass, the deputy technical director, becomes technical director. Mr. J. F. Stanley, previously divisional chief technical officer for electrical and related projects, is appointed deputy technical director (electrical). Professor C. A. Geneve, the divisional chief technical officer in charge of codes, personal safety, metallurgical and other standards work, is now appointed technical adviser (special duties) and he will be primarily concerned with developing standards projects for refrigeration, shipbuilding and structural work. Five former senior technical officers are now promoted to divisional chief technical officers with responsibility for one of B.S.I.'s main channels of work. They are Mr. R. Berry, Mr. P. Bingley, Mr. J. Brown, Mr. R. A. McKinstry and Mr. A. F. B. Nall.

Shuttle Minecar

A 10-TON payload shuttle minecar has been developed by Aveling-Barford Ltd., Grantham, at the instigation of Stewarts and Lloyds (Minerals) Ltd., which differs from the manufacturer's standard 10-ton machine in that it has a much reduced overall height of 7ft 9in. This height reduction has been achieved by setting operator's seat and controls closer to the footplate, dispensing with drive axle leaf springs, and by fitting a specially designed body. The body has an exceptionally low scow-end to allow operation with any underground loading machine likely to be teamed with it. The body loading height is only 4ft 10½in, whilst its capacity is 7 cubic yards heaped and its payload 20,000 lb. The operator is protected by a sheet steel canopy, but a back plate for the body can be added if desired—as loading is effected from the end rather than from above, the usual cab protection plate has been dispensed with to give a saving of some inches in height.



10-ton payload minecar being loaded with iron ore in a drift mine

Following the manufacturer's usual design the car has a reversible driving seat and dual controls so that the operator always faces the direction of travel, allowing the minecar to be reversed instead of laboriously turned around in the confined areas of tunnels. The standard transmission gives four forward and two reverse speeds between 4·23 and 24·5 m.p.h., and, if required, an alternative reduction gear can be fitted into the drive axle to reduce road speeds and so allow the full range of gears to be used. A Leyland 113 b.h.p., six-cylinder diesel engine used for the drive gives a power-to-weight ratio of 6·58 b.h.p. per short ton laden.

[Reply Card No. 1364]

Plastics Laboratory at Carrington

DURING the last ten years the growth of the plastics industry has been extremely vigorous and to-day is largely based upon the increasing use of oil as a source of essential raw materials. The Shell Group, as a natural corollary to its activities in the oil industry, has extended its activities into the plastics industry, and now manufactures vinyl polymers, polyolefins and polystyrene at its plant at Carrington. Here there is a large plant producing polystyrene, and a new polyolefins plant for the manufacture of high and low density polyethylene and polypropylene, while it is planned to install equipment for the large-scale production of diene rubbers. There are now concentrated on the Carrington site the technical resources for the production of plastics, which called for the availability of a laboratory to provide an overall technical service for customers, both manufacturers and end users. Temporary accommodation for such a laboratory was available in 1959, and this has now been replaced by the present buildings, which were started in April, 1960, and completed in August of this year. This fully equipped laboratory provides technical service in support of commercial activities, and is staffed by chemists, physicists, engineers and plastics technologists who command a knowledge of engineering and the industrial processes, and who not only deal with fundamental research, but are also concerned with product and application development, and the development of new equipment and methods of manufacture.

The new plastics laboratory has been designed to give the maximum flexibility, and for this purpose a system of several linked blocks was evolved. This resulted in speedy erection and economy in structure and made easy expansion possible. There are a total of seven blocks which are allocated to administration, the laboratory, offices, special purpose rooms, machine hall, workshop and engineering stores and raw material store. The total floor area is approximately 36,000 square feet, and it is of interest to note that plastic materials have been used, not in the nature of an experiment, but where the application was justified. Low density polyethylene waste pipe has been fitted in the laboratories and high density polyethylene is used for cisterns, while the sinks in the washrooms are of polypropylene. Wall tiles of polystyrene, and roof insulation of expanded polystyrene, are among the applications, which also include plasticised P.V.C. flooring, P.V.C. electrical conduit tube, rigid P.V.C. pipe and fittings for water cooling purposes, exterior panels of P.V.C. bonded to steel sheeting, and P.V.C. coated asbestos. Rain water goods include high impact P.V.C. gutters and down pipe.

As mentioned earlier, the work in the plastics laboratory will help customers by providing technical information on both products and processing equipment, and involves the testing of new and established thermoplastics, and fundamental research into properties relating to processing and performance. In the constant temperature and humidity room the instruments include an electronically controlled tensile testing machine, and in the application and performance laboratory one of the many activities is testing the formability of sheet material and evaluating materials for vacuum forming. Raw materials are tested, and flow properties established, over a wide range of rates of shear in a constant strain extrusion plastometer.

Training facilities are available for new personnel, and also for the company's sales and manufacturing staff, in which instruction includes the detection of the causes of faults and the remedy. A display room has on view a wide variety of articles manufactured in plastic, concerning which the company has developed an advisory service concerned with production techniques, materials and methods and suitability for purpose, both as regards the particular plastic and the application. For detail investigation of processing and fabrication there is a well-equipped machine hall, part of which we illustrate, in which are installed various designs and sizes of extruders, injection moulding machines, mills and compression presses. Also available are extruders with ancillary equipment for the production of : film, by the casting, quenching and blowing techniques ; pipe; monofilament; and bottles. Special machines are used for expanded plastics technology, powder technology and for solvent and heating welding. The machines have been selected to be representative of equipment used by customers, and to cater for a wide range of processing variables. An extensively equipped workshop not only enables installation and maintenance work to be carried out but can produce dies and moulds and build simple prototype process and testing machinery.

While on the site the opportunity was taken to visit the Carrington Research Laboratory which gives research support for the manufacturing and marketing operations of Shell Chemical Company Ltd. or Petrochemicals Ltd. The scope of the work covers : laboratory and pilot plant process work, examination of existing operations to improve process economics, and the development of polyolefins produced by low pressure techniques by the application of Ziegler/Natta organometallic catalysts. Improved grades of polystyrene are being sought and the chemistry of alkylene oxide polymers is being studied and investigations pursued in the field of paper and textile chemicals.

Part of machine hall showing some of the injection mouding machines

INDUSTRIAL NEWS

Industrial Films

A private showing of four new films on productivity was given in London last week by the British Productivity Council. "Change and Employment," a film which runs for twenty-six minutes, was made in co-operation with the European Productivity Agency of O.E.E.C., and shows some of the technological changes in recent years and how they have affected the lives of the workers. Contrast is drawn between the impact of change in present industrial circumstances and during the period of mass unemployment before the war. Examples of good management practice are given in situations in which new processes and methods have altered the labour content of the job and special emphasis is given to the importance of avoiding unnecessary hardship to employees.

The second film "A Case for Shiftwork?" emphasises the need for full and early consultation between management and the trade unions and that shiftwork is most likely to be successful when the system adopted is suited not only to the machines but to those who operate them. This film runs for thirty minutes. "The Man in the Middle" runs for twenty-eight minutes and tells the story of a foreman's difficulties in relation to the work study officer, the maintenance engineer, the quality control inspector and the other specialists' departments; it tells, too, of the well-intentioned attempt by management to solve this problem by sending the foreman and his colleagues on supervisory training courses.

The fourth film "Fitting the Job to the Worker" is an introduction to ergonomics, the study of man in relation to his working environment. It explains the principles of ergonomics and shows how they have been successfully applied to a number of industrial problems ranging from office work to the design and installation of a crane in a steel works, the display of controls in a power station, and the layout of a department in a shoe factory. This film runs for twenty-six minutes.

"The Peaceful Revolution," produced by Associated Electrical Industries Ltd., deals with India's industrial development and with her "five-year plans." The film describes the growth of electrical power in India and the parallel growth of education and technology, together with their effects upon industry, agriculture and village life. Of particular interest are the sequences dealing with Bhakra, the highest dam in Asia, and the heavy electrical plant at Bhopal, where some 25,000 skilled tradesmen will be trained in ten years.

Agricultural Machinery

Exports of agricultural engineering products increased by 4 per cent in the first nine months of 1961 compared with the corresponding period of 1960, according to figures issued this week by the Agricultural Engineers Association. Exports of machinery and implements, excluding tractors, were 11 per cent greater than in the first nine months of last year. Home sales of tractors have increased by 12 per cent during this period, whilst home sales of machinery and implements have improved by approximately 6 per cent. Production was approximately 6 per cent above that obtained in the first three quarters of 1960, the principal advance being in the machinery and implement groups.

Although profit margins are shrinking, the Association says, the overall position would seem to be satisfactory, the turnover figures for the period under review being better than they were at the end of 1960, which was a record year. In the light of its export record since 1956, the Association states that it considers that the British agricultural engineering industry has more to welcome than to fear from the prospect of Britain's entry into the Common Market.

Employment

During September, the Ministry of Labour says, the number of people in civil employment in Great Britain is estimated to have increased by 8000 to a new record figure of 24,008,000. The number of people employed in the manufacturing group of industries rose by 31,000 and this included an increase of 17,000 in the engineering and electrical goods sector. In shipbuilding and marine engineering the number employed rose by 2000 during September to 244,000, and in the motor vehicle industry there was also an increase of 2000, bringing the labour force up to 911,000. Outside of the manufacturing industries, the Ministry says, employment decreased in most industries and services.

In the week ended September 30, 1961, the estimated number of operatives working overtime in establishments with eleven or more employees in manufacturing industries, excluding shipbuilding and ship-repairing, was 1,951,000, each working eight hours overtime on average. This estimate was 176,000 more than at the end of August. In the same week, the Ministry adds, the estimated number of people working short-time in these establishments was 71,000, each losing sixteen hours on average. This estimate was 32,000 more than at the end of August, and, on average, four-and-a-half hours more were lost by each worker.

Trade with Japan

A report entitled "A Look at Japan" has been published by the Federation of British Industries following the visit last month to Japan of Sir Norman Kipping, director-general of the Federation, and Mr. John Whitehorn, deputy overseas director. Discussions between H.M. Government and the Federation during 1960–61 disclosed, the report states, that some revision of Anglo-Japanese trading relations must be foreseen.

The report contains statistics relating to approved technical agreements which have been negotiated with Japan up to August 31 this year. The United States has concluded 947 technical or "know-how" agreements, West Germany 141, Switzerland 112, Britain 51, and France 44. The authors formed the opinion that British industry was missing a valuable potential income. Other countries, above all the United States, have reaped the advantage of a wide familiarity in Japanese industry with their plant, and if there is any idea that withholding of "know-how" can retard the development of Japanese competition, the authors are sure it is an illusion.

Commenting on Japan as a market the report says that the expansion of Japanese industries cannot fail to lead to increased imports, but the assessment of Japan as a market for imported manufactured goods turns on the determination with which the Japanese Government is likely to pursue the policy of liberalisation. Anglo-Japanese trade is now running roughly in balance at the rate of £40,000,000 to £50,000,000 in each direction, but its further development, the report points out, hinges largely on the prospect of a commercial treaty which would supersede, save for a few remaining sensitive items, the present annual quota arrangements and under which—on terms and subject to safeguards—Britain would cease to discriminate against Japan under Article XXXV of the G.A.T.T. The authors consider that H.M. Government is right to be moving in the direction of "disinvoking" Article XXXV but warn that consequential adjustments must be gradual.

"Selling to Europe"

A National Convention which will "explore, in a full and frank way, all practical means of further expanding British exports to Europe" is to be held at Eastbourne from November 29 to December 2, under the auspices of The Export Council for Europe. It will be attended by some 500 United Kingdom businessmen who will be divided into groups by industries. The list of industry groups includes heavy engineering, heavy transport and mining machinery, electrical and electronic engineering, producers' goods, aircraft and motor, machinery, and light engineering. Export opportunities in each of the nineteen countries in Western Europe are to be discussed with the assistance of experts from those countries.

The Rt. Hon. Selwyn Lloyd, Chancellor of the Exchequer, is to address the opening plenary meeting on November 29, and the opening address will be given by Sir William Macfadzean, chairman of the Council. Sir Norman Kipping, director-general of the Federation of British Industries, will sum-up.

Employment and Apprenticeships

The absorption into employment and training of this year's summer school-leavers was considered by the Industrial Training Council at its meeting last week. The figures showed, the Council said, that this year—when there were 45,000 more summer school-leavers than last year—the percentage of leavers still without a job in October was 1 per cent compared with 1·4 per cent last year.

Both the numbers and percentage of boys obtaining apprenticeships has increased, the Council states. Compared with the same period last year 11,000 more boys got apprenticeships, the percentage increasing from 36 per cent to 38 per cent. In certain regions some apprenticeship vacancies still remained unfilled.

While welcoming the progress made in absorbing summer school-leavers into employment and training this year, the Council points out that the greatest impact of the bulge will be felt in 1962, and that industry will need to continue and intensify its efforts to provide suitable employment and training opportunities for these young people.

PERSONAL AND BUSINESS

Appointments

PLESSEY INTERNATIONAL LTD. announces the appointment of Mr. G. H. Doust as a director.

BRIGADIER JOHN CLEMOW has been appointed engineering director of G.E.C. (Electronics) Ltd.

AIR VICE MARSHAL G. SILYN-ROBERTS has joined Electro-Hydraulics Ltd. as engineering consultant.

MR. D. W. SMITHERS has been appointed as director of dockyards, Admiralty, in succession to Mr. I. E. King.

WOLSELEY ENGINEERING LTD., announces the appointment of Mr. F. Dean Swift to its board of directors as sales director.

MR. K. W. MCBAIN, M.I.Mech.E., M.I.E.E. has been appointed chief engineer of The Micanite and Insulators Company Ltd.

WOLSELEY ENGINEERING LTD. announces the appointment of Mr. G. R. Hands to its board of directors as marketing director.

MR. W. G. BOND has been appointed a joint general manager of Elliott Brothers (London) Ltd., a member of the Elliott-Automation Group.

BRUSH ELECTRICAL ENGINEERING COMPANY announces the appointment to the board of Mr. F. H. Wood, Dr. L. R. Blake, and Mr. R. A. Grierson.

MR. C. J. EVANS, A.M.I.E.E., has been appointed southern area sales manager of Efco Furnaces Ltd. and will take up his new appointment on December 1.

MR. G. W. LEECH, A.M.I.E.E., has been appointed chief engineer, power transformers (Rugby), in the transformer division of Associated Electrical Industries Ltd.

HENRY WIGGIN AND CO. LTD. states that Mr. R. E. Ansell has assumed the title of sales director and Mr. C. Bowles has been appointed to the position of sales manager.

SHAW SAVILL AND ALBION COMPANY LTD. announces that Mr. W. R. Russell has been appointed general manager, following upon the retirement of Mr. Ralph Hodson.

MR. RALPH CHILES, chairman of Prince-Smith and Stells Ltd., has joined the board of Textile Machinery Makers Ltd. Both companies are members of the Stone-Platt Industries Group.

MR. R. JOHNSON has been appointed works manager (melting shops) and Mr. R. Wogin has been appointed works manager (rolling mills) at United Steel Companies' Appleby-Frodingham Steel Company branch.

MR. NORMAN CARE, M.I.E.E., M.B.I.M., general sales manager, Aberdare Holdings Ltd., and general manager, South Wales Switchgear Ltd., has been appointed a director of the Neckar Water Softener Company Ltd., a member company of the Aberdare Group.

EDGAR ALLEN AND CO. LTD. announces that Brigadier Levesley, M.I.Mech.E., has been appointed President of the Welded Tool Manufacturers' Export Association and of the Welded Tool Manufacturers' Association, in succession to Mr. R. P. Wallace of Jessop-Saville Ltd.

BRITISH EXECUTIVE AND GENERAL AVIATION LTD. announces that Sir Mark A. Norman, Bt., is to be appointed commercial director of the BEAGLE Group and a director of BEAGLE-Auster Aircraft Ltd. and of BEAGLE-Miles Aircraft Ltd. He takes up his appointment on November 20.

THE ENGLISH ELECTRIC COMPANY LTD. has made three new senior appointments to its control gear division at Kidsgrove, as follows : Mr. F. E. Waspe, A.M.I.E.E., chief development engineer ; Mr. G. H. Gunnell, A.M.I.E.E., chief control engineer ; and Mr. E. J. Pepper, A.M.I.E.E., chief design engineer.

MR. KENNETH A. SMITH, a director of Firth Cleveland Steel Strip Ltd., has been appointed a director of Firth Cleveland Steel Ltd. and of the associated company, J. J. Habersohn and Sons Ltd. He will have full executive responsibility over the whole field of steel strip production, and will be based at Holmes Mills, Rotherham.

Contracts

HENRY SIMON LTD. has received an order from William Crawford and Sons Ltd. for a plant to bulk-store and grind granulated sugar and convey weighed batches of ground or granulated sugar to the factory mixing bins at the company's Liverpool works.

Business Announcements

ELGAR MACHINE TOOL COMPANY LTD., 172-178, Vulcan Road, London, W.3, has been appointed the exclusive distributor in the United Kingdom for the internal keyseating machines manufactured by Maillefer S.A. of Lausanne, Switzerland.

G. AND J. WEIR LTD. states that under an agreement which came into effect on August 12, 1961, it will take up a licence to manufacture and market in the United Kingdom the products of Pacific Pumps Inc., a Division of Dresser Industries Inc., of Los Angeles, California, U.S.A. Selling arrangements for "Weir-Pacific" pumps are being handled by existing staff at the branch offices and at the Weir headquarters at Cathcart, but in the London area Mr. Davin R. Murison, formerly manager of the Weir Birmingham office, has taken over Weir-Pacific sales from the Weir office at 37, Mincing Lane, E.C.3.

CHARLES CHURCHILL AND CO. LTD., South Yardley, Birmingham, announces that a new company, Dorsett Marine Ltd., has been added to its group of subsidiary firms. The new company has been formed to manufacture in this country the range of motor boats made in the United States by Dorsett Marine, a division of the Textron Company, one of the largest boat making concerns in America. A new factory of over 10,000 square feet is to be built on the South Coast for the company, which will initially produce two designs of 15ft and two designs of 17ft cruisers. All boats of this concern have hulls and decks of resin bonded glass fibre, and they can be powered by any make of outboard motor.

NAPIER AERO ENGINES LTD., a company owned equally by D. Napier and Son Ltd., and Rolls-Royce Ltd., has been formed and will carry on the aero-engine business of D. Napier and Son Ltd. The board of Napier Aero Engines Ltd. is as follows : Mr. J. D. Pearson, chairman ; The Hon. George Nelson, deputy chairman ; Mr. H. E. C. de Chassiron, managing director ; The Rt. Hon. the Viscount Caldecote ; Mr. F. T. Hinkley ; Sir Archibald Hope, director of sales ; Mr. A. A. Lombard ; Sir John Paget, works director ; Mr. A. J. Penn, technical director. Arising from this, the board of D. Napier and Son Ltd. has been reconstituted as follows : The Hon. George Nelson, chairman ; Mr. G. A. Riddell, deputy chairman ; Mr. P. L. Daglish, managing director ; The Rt. Hon. the Viscount Caldecote ; Mr. H. E. C. de Chassiron ; Mr. P. Horsfall.

B.S.A. TOOLS GROUP LTD., a new holding company, has been formed from the ten companies previously included in the B.S.A. Tools Division. All are subsidiaries of the Birmingham Small Arms Company Ltd. The board will be Mr. Eric Turner, chairman, Mr. S. A. Roberts, managing director, Mr. C. H. Angell, Mr. E. W. Hunnisette, Mr. W. H. Pearse, Mr. H. C. W. Trapmore, and Mr. T. N. Woof ; secretary, Mr. M. Dunstan-Smith. Mr. S. A. Roberts will be chairman and managing director of the following subsidiaries : B.S.A. Tools Ltd.; Burton, Griffiths and Co. Ltd.; B.S.A. Small Tools Ltd.; B.S.A. Broach Company Ltd.; B. G. Machinery Ltd.; B.S.A. Electrics Ltd.; Precision Alloy Castings (Birmingham) Ltd.; Automation Jigs and Tools Ltd. Mr. Eric Turner, chairman of the parent Birmingham Small Arms Company, will be a member of each of these boards and chairman of the Churchill Machine Tool Company, of which Mr. Roberts will be deputy chairman. Mr. Turner will be president of B.S.A. Tools (Canada) Ltd., and Mr. Roberts, vice-president.

JAGUAR CARS LTD has acquired the business and physical assets of Guy Motors Ltd. from the Receiver appointed by Lloyds Bank Ltd. This sale makes possible the continuance of the Guy Motors business, although it will not enable the debt due by Guy Motors Ltd. to the bank to be paid in full. A statement issued by the directors of Guy Motors Ltd. stated : "The directors of Guy Motors Ltd., regret to announce that following the sale of the Company's business and physical assets to Jaguar Cars Ltd. there will not, according to present information, be sufficient funds available to pay in full the debt to the Debenture holder after meeting the claims of Preferential creditors, and accordingly nothing is expected to be available for other creditors or for return to shareholders. A petition is being presented to the court for the compulsory winding up of the Company by order of the Board."

THE GENERAL ELECTRIC COMPANY LTD., has announced the formation of two new operating companies, G.E.C. (Telecommunications) Ltd., and G.E.C. (Electronics) Ltd., to take over the activities of the company's telecommunications group. Co-ordination and direction of these companies will be undertaken by a newly formed holding company, G.E.C. (T. & E.) Holdings Ltd. The holding company will also be responsible for co-ordinating and directing the activities of the following subsidiary companies : The M-O Valve Company Ltd., Salford Electrical Instruments Ltd., Watson and Sons (Electro-Medical) Ltd., Machlett X-Ray Tubes (Great Britain) Ltd., and of the G.E.C. Semi-Conductor Division. Mr. O. W. Humphreys has been appointed executive chairman of the holding company and chairman of the two new operating companies. Mr. W. A. C. Maskell has been appointed director of the holding company. Mr. C. Riley and Mr. R. J. Clayton have been appointed directors and general managers of G.E.C. (Telecommunications) Ltd. and G.E.C. (Electronics) Ltd. respectively. The headquarters of G.E.C (Telecommunications) Ltd. will be at G.E.C. Telephone Works, Coventry, and of G.E.C. (Electronics) Ltd. at Union Works, Wembley. The main production units of G.E.C. (Electronics) Ltd. will be at Spon Street and Ford Street, Coventry, Broad Oak, Portsmouth and Union Works, Wembley.

Miscellaneous

SHIP STRUCTURES CONGRESS.—The inaugural meeting of the International Ship Structures Congress held in Glasgow on September 19, 20, 21 was attended by delegates from sixteen countries. Reports of the committees on "Wave Loads," "Response to Wave Loads" and "Plannning a Long Range Research Programme on Ship Structural Design" were discussed and new committees appointed. Other subjects reviewed included : low cycle fatigue, hull vibration, orthogonally stiffened plate fields, superstructures, dynamical pressures in oil tanks and design of large tankers. The next meeting of the Congress will be held at Delft in 1964 under the chairmanship of Professor H. E. Jaeger.

FORK TRUCK FACTORY EXTENSIONS.—Early this year it was announced by Conveyancer Fork Trucks Ltd., that it was forming, in association with the Raymond Corporation of America, a new company Conveyancer-Raymond Company, to manufacture and distribute in this country and abroad, the Raymond range of fork, straddle and pallet trucks. To provide the necessary increased production facilities for the new concern a 52,000 square feet factory extension and new offices have been opened at the Thornton Road, Warrington, site of the organisation. In the assembly buildings hitherto in use, production was arranged on the line basis with overhead conveyor systems feeding sub-assemblies to the main lines. Space is now being made available in these buildings for additional assembly lines by transferring sub-assembly work, special equipment production, packing and despatch sections to the new extension. Also to be set up in the extension is a new, heavy, machining section for the manufacture of fork truck parts, this will make additional space available in the firm's Liverpool Road factory for the manufacture of aircraft equipment.

"INTRODUCTION TO THE '1301.'"—A concise film introduction to the new I.C.T. 1301 electronic data processing system is available on free loan from International Computers and Tabulators Ltd., Publicity Division, Gloucester House, 149, Park Lane, London, W.1. The film briefly examines each of the units in the system and indicates the way in which they have been developed to meet the requirements of a wide variety of applications. From the heart of the '1301,' the audience is taken on a section-by-section "tour" of the system, giving vivid impressions of the fast operating speed by shots of the punched card input, reading eighty-column cards photo-electrically at a speed of 600 a minute ; and of the output printer, operating at speeds of up to 600 lines a minute, with 120 character positions in each line. The film shows how the system allows for the on-site increase of immediate access core storage from 400 to 2000 words, of drum storage from one to eight drums, and the fitting of from one to eight magnetic tape decks. Production is by Cinechrome Ltd., and the film stock is Kodachrome 16mm sound. Running time is eight minutes.

CONTINENTAL AFFAIRS

by Our Continental Editor

Electronic Circuits in Railway Signalling

The development of electronic techniques, particularly those using semiconductor devices, for railway signalling circuits in France was described in a paper on electric signalling, by Monsieur J. G. Walter, Chief Signal Engineer, French National Railways, presented to the Institution of Railway Signal Engineers in London on November 15. The following summary deals with this aspect of his contribution.

IMPORTANT developments in electronic track circuits have resulted from experiments undertaken by the French National Railways in connection with the electrification of lines at 25kV, 50 c/s. From the outset single-rail d.c. track circuits were used on double-track lines, but have not been continued because of certain drawbacks from the signalling point of view. One of these is that a broken rail, unless it is the insulated one, is not detected automatically. The rail used for the return current may be broken at one point, or even two, and the track relay will remain energised. Another drawback is that only half the section of the rails is available for the passage of return currents.

Reduction of voltages induced in lineside conductors by a.c. electrification is a constant preoccupation, and preference must be given to double-rail track circuits where return current runs symmetrically through each rail. From a general point of view, there are advantages in using alternating currents of various frequencies. With d.c. it is necessary for there to be cabling without discontinuities right up to the apparatus —to relays for example—and this makes it necessary to limit induced voltages to a value not much higher than 60V. When using a.c., however, a transformer can be introduced before the connection to the apparatus and it is then possible, according to C.C.I.T.T. rules, to allow an induced potential of 60 per cent of the disruptive voltage. This advantage is so important that in many cases it is worth replacing conventional equipment by new devices, and electronics offer a wide choice of possibilities in such replacements.

First attempts to solve the question of interference in a.c. track circuits on 25kV electrified lines took the form of using a frequency different from the 50 c/s traction supply, but close enough to it to take advantage of experience already gained with 50 c/s as a signalling frequency. Reliable installations were provided by the use of 83⅓ c/s, but numerous signalling substations were needed for the generation of such a supply, while special cables were needed for the distribution. Since industrial-frequency traction simplifies substations and feeders, it was desirable to find a cheaper system for signalling also. These considerations gave rise to a great variety of electronic track circuits on the French 25kV a.c. lines. All have the common feature that electronic devices using valves or transistors are fed at 50 c/s either from the traction overhead supply, the grid system, or an emergency source, and generate *in situ* the special currents to be sent to the track.

At the beginning of French 50 c/s electrification semiconductors were insufficiently developed for signalling purposes, and specially-manufactured valves were used. Their performance in 3200 track circuits has been quite acceptable. The development was carried out by the Compagnié de Signaux et d'Entreprises Electriques in close co-operation with the French National Railways. Several frequencies are used to meet the case of insulated rail joints failing, and the output of the transmitter for one track circuit reaching the receiver of the next one. In such circumstances the receiver should not respond, or, better still, should be de-energised. Finally four frequencies were adopted—300 c/s and 850 c/s for long track circuits, and 1500 c/s and 2000 c/s for the shorter ones in stations. The first two frequencies are coded by twenty to forty interruptions per second, but there is no coding of the two higher frequencies. A valve oscillator is used in each transmitter, while in the receivers for 300 c/s and 850 c/s a similar valve is used as an amplifier. No amplifier is needed for the short track circuits. Conventional relays are used, energised by the decoded and rectified current of the receiver.

The next step was the transistorised a.f. track circuit, still using insulated rail joints. Here the firm collaborating with the French National Railways has been T.R.T. (Télécommunications Radioélectriques et Téléphoniques), who use a narrow-band system, without coding, operating at 110, 180, 210, 275 and 315 c/s. The first three are able to operate track circuits of a minimum length of 2 km, and the other two operate over lengths of 1·5 km. Each track circuit is fed from an 8V battery, the transmitter consuming about 20W, and the receiver 2½W. The transmitter consists of a high-stability oscillator followed by three symmetrical amplifiers, the last coupled to the impedance bond. The receiver has four stages, comprising a filter with a pass band of only a few cycles, a limiter determining the voltage level of received voltage at which the relay will pick up, a non-linear filter to eliminate unwanted frequencies or signals, and an amplifier feeding the relay through a rectifier.

Monsieur Walter's paper then proceeded to describe two forms of track circuit in which insulated rail joints are not required, the circuit limits being defined by physical phenomena such as impedance and resistance of the track. One form of "jointless" track circuit is the overlay circuit used in France and elsewhere where it is necessary to detect the presence of a train at a particular point within a track circuit of normal form. Its early application in France was at level crossings equipped with flashing lights and automatic barriers, where there was no need for the overlay circuit to be longer than the width of the crossing. More recently another jointless track circuit has been designed by the Aster company which can be installed on main lines and become part of an automatic block installation. In such cases it can extend for about ½ mile. Frequencies used lie between 1600 c/s and 2800 c/s.

The principle of this circuit is shown in Fig. 1(*a*), where it is seen that its limits are defined by a circuit at each end consisting of a loop extending over a certain length of rail. In principle the loop comprises a cable *AB* (and A^1B^1) short-circuiting the rails, and a condenser which is connected between the rails at a particular distance from the cable. Such a loop forms an oscillatory circuit of a definite frequency.

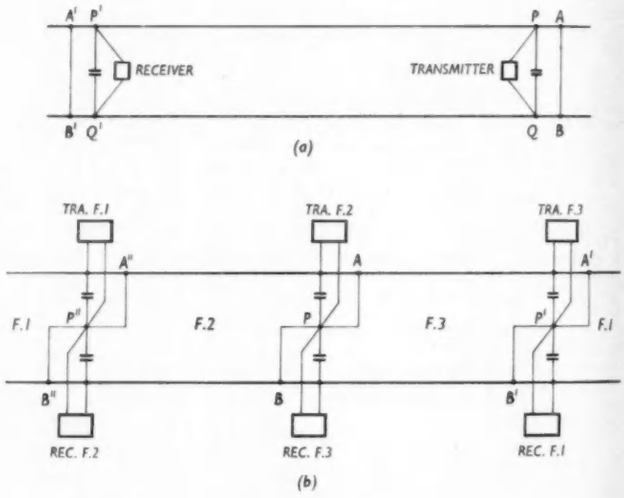


Fig. 1—(*a*) Audio-frequency track circuit without insulated rail joints —basic principle; and (*b*) arrangements adopted in practice

In practice this arrangement is modified, as shown in Fig. 1(*b*) since a train standing on *AB* (or A^1B^1) would not shunt the circuit and de-energise the relay. Therefore points *A* and *B* are staggered, and the cable between them is connected from its mid-point *P* through one condenser to the other rail and to a receiver, and through a second condenser to the other rail and to the transmitter. Lengths *PA* and *PB* are such that, in association with the condensers, two circuits are formed having the frequencies F2 and F3 respectively (i.e., the frequencies to be injected into one circuit by the transmitter, and picked up from the other by the receiver). Although the voltages are not quite equally divided between the two rails, the difference is very slight owing to the values of the impedances in the elements of the loops. Three frequencies

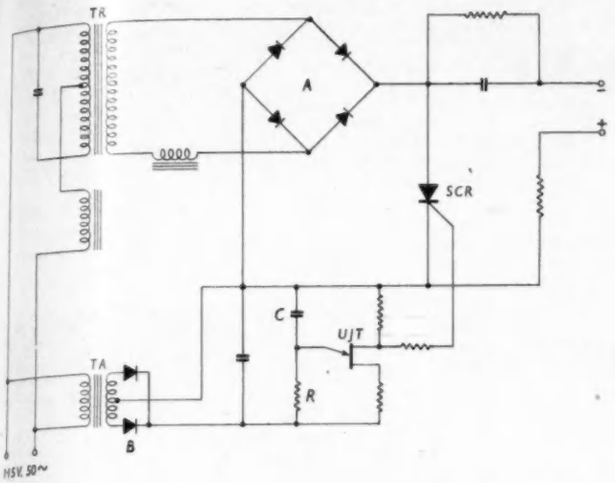


Fig. 2—High-voltage impulse transmitter for track circuit

are used, and each loop is a short circuit for the frequency ahead. Different groups of frequencies are used on up and down tracks. Transmitters and receivers are fed by an 8V signalling battery and their consumption is 3W to 4W. The voltage on the track is 0·5V.

Where track circuits are over ½ mile in length with this system, an intermediate receiver and transmitter are provided. When no train is present, this receiver picks up a signal and biases the transmitter so that it re-transmits.

A further form of track circuit described in Monsieur Walter's paper is energised by high-voltage impulses. At first the impulses were generated by a thyratron, which needed a d.c. supply of about 1500V, but the latest arrangement uses a silicon-controlled rectifier as shown in Fig. 2. The supply is taken at 115V, 50 c/s, and applied to the controlled rectifier, SCR, by the diode bridge rectifier *A*. Triggering impulses for the control electrode of SCR are provided by the unijunction transistor UJT, fed by full-wave rectifier *B* consisting of two 100V silicon diodes. This form of transistor (also known as a double-base diode) has a negative resistance characteristic which enables it to operate as an oscillator without feedback, oscillations being maintained by the alternate charging of condenser *C* through resistance *R*, and its discharge when the emitter contact reaches a certain potential.

Some 2000 high-voltage impulse track circuits are in service in France at present. Impulses are delivered at about 100V and at a frequency of three per second. They are used to energise the track relay through a condenser and rectifying valve or diode. An impulse system has the advantage of ensuring that the wheels of a vehicle provide an effective short circuit. In all cases where the surfaces of wheel and rail are not completely clean, the higher voltage of the impulses is a great help towards short-circuiting the track relay. In addition, the short-duration pulses economise in power and are harmless to men working on the track. While they would not break through heavy sanding, they have been fully effective with the reduced sanding which has been found by experiments on the French National Railways to meet practical requirements, and has been secured by modifications to locomotive sanding equipment.

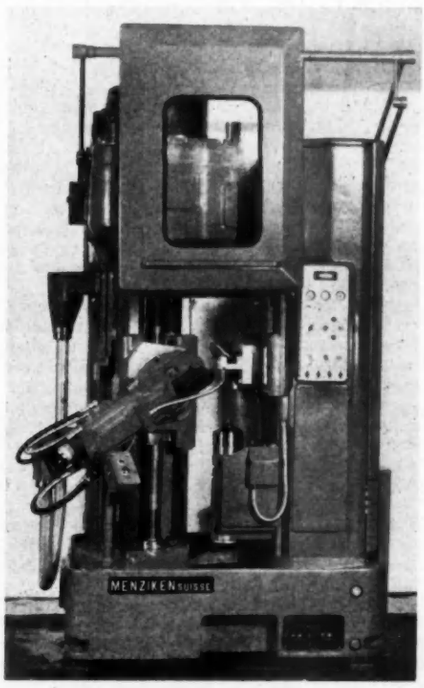
Other sections of Monsieur Walter's paper dealt with the evolution of push-button signalling, and with the electronic centralised traffic control between Mouchard and Frasne on the Dijon–Dôle–Vallorbe line. Control signals are sent from the panel at Mouchard by frequency-shift of the transmitting carriers, trains of impulses so formed beginning with a five-impulse code identifying the remote station unit required. This is followed by four impulses giving the order to be carried out. The duration of each impulse is 20 ms. Indications are returned to Mouchard in the course of a continuous scanning cycle which connects each piece of remote apparatus in turn to the corresponding indicating device. A complete scan occupies two seconds. Several carrier frequencies are used, each sending forty indications in eight groups of five impulses.

Most of the C.T.C. equipment is electronic, and much use is made of semiconductors. Such devices are used throughout the programming unit at Mouchard which allows the operator to pre-select up to four routes, which are stored and then set up as conditions permit.

Automatic Vertical Turning Machine

A NEW model of the vertical turning machines made by the Menziken Machine Works Ltd., Menziken, Switzerland, is available with a hydraulic copying slide and either numerical or cam control for automatic operation. As can be seen from our illustration the machine is of the same general design as the firm's other machines, having a closed frame to impart a high degree of rigidity in heavy machining, and being suitable for the fitting of independent slideways round the working area to provide for the particular requirements of the user.

These machines take work up to 10in diameter and 28in long between centres and through a four-speed gearbox and change gears have spindle speeds from 175 to 3500 r.p.m. The gearbox permits the automatic selection of any four speeds in a ratio of 1 : 4 to be achieved during a turning sequence. The feed gears are driven through a variable speed unit from the main spindle to give the saddle, through change gears, a stepless range of sliding feeds from 0·002in to 0·018in per revolution, and 0·004in and 0·036in per revolution. A rapid saddle traverse speed of 236in per minute is also available.



Automatic vertical turning machine fitted with hydraulic copying slide

The copying slide, which has a stroke of 7in, takes its vertical feed drive through the feed gearing and a lead screw. It can be tilted up to 30 deg. either side of the horizontal centre line to enable recesses to be machined in both directions of travel. An undercutting slide on the main column of the machine can be fitted with a four-way tool post and depending upon the requirements of the work one or two undercutting slides can be mounted. The tailstock is actuated electro-mechanically and spring inserts are incorporated to provide for any expansion of the workpiece during machining.

Soviet Proton Accelerator

A 7 GeV proton accelerator has recently been completed and is now being adjusted at the Soviet Institute for Theoretical and Experimental Physics. The machine which has a magnet circle 80m in diameter, follows the principles of similar accelerators at Geneva and Berkeley, in particular as regards the "strong focusing" of the particles. This permits the chamber section to be reduced to 8cm by 11cm, as compared with 40cm by 150cm in the case of the proton synchrotron of the Joint Nuclear Research Institute. The ring incorporates 112 magnet blocks, representing the comparatively modest amount of metal of 3800 tonnes. One of the drawbacks of "strong" focusing lies in the very high degree of accuracy required on setting up the machine and adjusting the magnetic fields. Work on the design began over eight years ago. A larger machine, of between 50 and 70 GeV, based on the same principle, is under construction.

Petrochemical Expansion

On completing the first stage of construction between 1957 and 1961, at a cost of more than DM.300 million, Erdölchemie G.m.b.H., Dormagen, has now begun to construct further plants for which a sum of DM.340 million has been allocated. The company is a subsidiary of BP Benzin und Petroleum A.G., Hamburg, and Farbenfabriken Bayer A.G., Leverkusen. On completion of the expansion programme, production will include (in thousands of tonnes per annum), ethylene (115); ethylene oxide (36); mono-, di- and tri-ethylene glycol (32); ethanol (54); propylene (110); propylene oxide (28); propylene glycols (7); acrylomitrile (25); butyraldehyde (12); butadiene (60); isoprene (12); isobutylene monomer (12); di-isobutylene and tri-isobutylene (45); N-butene-1 and N-butene-2 (50).

Swedes' Paper Consumption Doubled in Past Decade

Paper consumption in Sweden is reported to have increased from 65 kg to 121 kg per head of the population in the period 1950–60, which is the biggest rise noted in any country during the decade. The next largest increase during the period was in the British Commonwealth, from 61 kg to 107 kg per head of the population.

In 1960 Sweden came third in the world in paper consumption per capita, the highest consumption being that of the U.S.A. (196 kg), followed by Canada (127 kg). The Commonwealth came fourth. The world's average paper consumption in 1960 was 25 kg per head of the 2,963,000,000 population.

Sea-Going Hydrofoil Ship

The diesel-powered hydrofoil ship "Mir," a vessel capable of carrying ninety-two passengers at a speed of 75km.p.h., has completed her maiden voyage on the Black Sea. The "Mir" has a light alloy welded hull, and is equipped with remote controlled engines and automatic steering gear. The saloon is fitted with reclining aircraft-type seats. The vessel is said to have a range of 600km. A larger design for up to 300 passengers and with a longer range is stated to be in preparation.

THE AMERICAN SCENE

By Our American Editor

Progress in Data Communication

IT is anticipated in the United States that by the end of this decade, if not sooner, all the conventional forms of contact in the business world will have undergone a basic change. After generations of person-to-person dealing—by telephone or telegram, messenger or mail, or across-the-table conference—the communication of data is becoming automatic. Some indicators of the change already are in sight: lightning-fast teleprinters; computers which can exchange data over thousands of miles without need of human hand or voice; orbiting transmitters in the sky. No less significant than the advances in equipment are some fundamental revisions and extensions of the familiar channels of communication. Western Union, for example, is modernising its "Telex" private-wire service and expanding its nationwide facilities, and the American Telephone and Telegraph Company (A.T. & T.) is hooking up a variety of business machines directly to its Bell System lines for the first time, using a new technique called "Data-Phone." Recently, too, have come two very significant decisions by the Federal Communications Commission: one, permitting private firms to install their own microwave communications networks; the other, allowing A.T. & T. to counter this potential threat to its carrier business by initiating a service called "Telpak." In one way or another, every American businessman ultimately will have access to national networks of many kinds of communicating media, as quick and simple to use as the telephone on his desk. Access to these networks will be through business machines, which will do most of the talking and writing for him. Such a revolution is likely to alter profoundly the size and shape of the vast American communications industry.

In the United States to-day, the existing conventional means of business communication are (1) the U.S. mails; (2) the private messenger services; (3) the telephone system, with equipment and circuits leased or rented from the common carriers; (4) public telegraphy, again using a common carrier; (5) the teletype service (T.W.X.) of the Bell System, modelled after its nationwide telephone service; (6) the private-wire circuits leased from both A.T. & T. and Western Union, over which are transmitted teletype messages, facsimile images or Dow-Jones ticker copy and (7) private radio hook-ups, which connect taxicab fleets, airlines and other transport services. All these communications media in recent years have undergone conspicious improvement, and over half the Bell telephones now in service, for instance, can reach any other without calling on an operator. To-day one trend is to extremely fast teleprinters, which get their input straight from a computer, by punched tape. For example, the Burroughs S202 Teleprinter, developed specially for the U.S. Army Signal Corps, does away entirely with typewriter keys. Instead, letters are projected on to special paper electronically by means of a row of matrices, each containing thirty-five tiny pinheads of electrodes. As code pulses are transmitted to the matrix bank, they are formed in the style of numeric or alphabetic characters, a line at a time. The machine can print 30,000 such characters a second—a speed fifty times as fast as a news service teleprinter, and some twenty times as fast as most people talk. Developments are also coming along rapidly in fascimile, or "graphic communications." This is a means of transmitting and reproducing on paper not only typewritten pages, but also handwritten copy, drawings, blueprints and even photographs. Various tones of shading from black to white are picked up in the transmitting machine by an optical scanner and sent out as a series of pulses; at the recording end, they are deposited on dampened paper in much the same way as metals are electroplated. In this way, a letter-sized piece of copy can be reproduced in just three to six minutes.

Such equipment, of course, is of incalculable service to businesses of every description. With it, the engineer in one works can send technical drawings almost instantly to a colleague in another works, rather than try to describe the work by telephone, dispatch it by air mail or get aboard an aircraft to deliver it by hand. Publishers now make extensive use of facsimile in sending copy back and forth between writers, editors and printers. Perhaps the best evidence of the value of "fax" has been demonstrated by the New York Telephone Company itself, which has one of the largest systems in the country. Also growing in importance is the related field of handwriting transmission, or "telewriting." The process involves the instantaneous transmission of a message as it is being penned. A special stylus is used by the writer, who generally fills out a printed form, and the receiver's automatic stylus records the message on another form. With its so-called "Telescriber," the TelAutograph concern for years dominated the field. The latter, however, has been somewhat limited because the company could make it available only on private lines leased from telephone carriers. More recently, however, the Comptometer Corporation also entered the field, with a similar device which it calls the "Electrowriter." Then, last year, as the Bell engineers were bringing their "Data-Phone" concept into the final stages of development, A.T. & T. advised both firms that their respective instruments could be used in connection with the Bell System if adaptations to certain specifications were made. Now, Comptometer's device is the only telewriter yet adapted for "Data-Phone," but A.T. & T. is co-operating with TelAutograph in the latter's efforts to make the "Telescriber" which long has been compatible with private telephone circuits, equally compatible for dialling via "Data-Phone."

As for communication to and from computers, the first American large-scale system involving a computer at all was installed by Western Union for Sylvania Electric Products in 1956: a 20,000 mile private-wire network feeding teletypewriter data from 96 offices and branches around the country into a data-processing centre in New York State. Since then, a number of systems have been installed, both by carriers and the computer makers themselves, such as IBM and Sperry Rand, using the leased wires of major utility companies or newly constructed microwave facilities. Now the trend is to actual communication between computers. In this field the Kineplex systems of the Collins Radio Company provide direct communication over any leased common-carrier lines. Included generally are "Kinetape," "Kinecards" and, most important, Kineplex data-modulation equipment. Another significant product with wide adaptability is Friden's "Teledata". Using telegraph or telephone lines, "Teledata" sends punched paper data into a Friden "Computyper", or "Flexo-writer," where it is decoded and printed, as part of a larger system called the "Collectadata." Friden's unit permits automation of a whole series of management processes, including production and inventory control, labour distribution, and payroll.

All these advances in equipment have been inspired by changes in the underlying techniques themselves. Every form of business communication mentioned is carried over a nation-wide complex of telephone and telegraph circuits. Those circuits range from the narrow "voice" channels which are the industry's basic common dominator to the broadband ones, like microwave, on which up to 11,000 messages can be carried at the same time. Most private-wire circuits have been leased for transmission of one kind of data—teletype, facsimile, &c. The common-carrier networks, too, have been restricted. Western Union's 5,000,000 miles of circuits, nearly all leased from A.T. & T., by contract agreement send record messages and nothing else. Bell's T.W.X. network is limited by the equipment installed for its use. Finally, A.T. & T.'s millions of miles of telephone circuitry until recently carried nothing but human speech. Now fundamental changes are afoot. With so great and flexible a capacity already available, it was foolish to think of going outside the industry to start a new system to carry the added loads of automation. To improve its own position in this fiercely competitive battle, Western Union has made several moves to enlarge the services it offers, to improve those it already has and to extend the geographic range of its operation. The company has asked A.T. & T. to open negotiations on modifying its contracts, which now prevent the telegraph company from using its leased circuits for voice transmission. More positively, Western Union has embarked on two major programmes of expansion. First, to improve the efficiency of its private-wire service, the company has developed Telex, a soundly conceived threat to the dominance of A.T. & T.'s T.W.X. network of teletypewriters. Since 1958, Telex has offered both faster and, in high volume use, cheaper service to teletypewriter subscribers in four major cities: New York, Chicago, Los Angeles and San Francisco. Teletype machines in these cities can reach each other instantaneously by dialling and, because of a unique "answer-back" aspect, they can send messages even if the one on the receiving end is unmanned, as at night. Moreover, while T.W.X. makes a minimum three-minute charge for the use of the line, Telex charges customers only for actual time used. Like T.W.X., Telex can be operated by punched paper tape and so can be integrated in certain types of data-processing installations.

As a second major phase of its plans, Western Union has been building new microwave circuits with which to relieve its heavy dependence on the Bell System. In this way, it hopes to add greatly to its government business. Both the US Weather Bureau and the Federal Agency use a 24,000 mile network leased from Western Union for transmission of weather maps and other meteorological data via high-speed facsimile. This service recently was offered as well to private companies licensed to receive official U.S. weather reports. Now Western Union is about to begin installing a national network for the transmission of computer data for the U.S. Air Force on specially constructed circuits. The system is called "Comlognet" (Combat Logistic Network) and will link five centralised computer centres with 240 domestic air bases and installations and ultimately with 111 overseas air stations. Apart from being the world's

largest private-wire system, the special aspect of "Comlognet" will be its sophistication. It will be capable of handling the equivalent of 7,000,000 IBM cards, or roughly 100 million words, per day; furthermore, the data can be sent by facsimile or teletype or in computer language. A further expansion of point-to-point service within the system may be called for if and when "Comlognet" gets into operation next year.

While Western Union has been forging ahead on all these fronts, A.T. & T. has been far from idle. The first break with tradition was its introduction of Wide Area Telephone Service. Known as W.A.T.S., this plan permits big long-distance customers to reduce their telephone bills substantially by paying a flat rate either for fifteen hours of calls per month or for an unlimited number to any of six regional U.S. zones. More far-reaching yet is A.T. & T.'s development of "Data-Phone." In the face of rising demand from big customers with business interests across the country, for private circuits over which to transmit machine data faster and in greater volume than the mails or the teletypes could carry it, A.T. & T. has now introduced its "Data-Phone" concept commercially, making the whole Bell System available for its use. The "Data-Phone" itself is a box-like instrument with a telephone attached; one is hooked up to, say, a computer in Chicago, while a second is installed next to another machine, perhaps in Los Angeles. A man at Chicago, by dialling the "Data-Phone" at Los Angeles, then can establish a circuit between the two machines exactly as he would with another person by dialling an ordinary telephone. When the circuit is complete, in a few seconds, the electronic brains transmit their data to each other. For most situations it is cheaper, simpler and more convenient than any other method of long-distance data communication yet devised. Furthermore, since human hands do nothing but dial the number, it is virtually error-free. The initial installations with which the Bell Telephone engineers worked to perfect "Data-Phone" now involve 1200 units, all of which are in regular on-line service. The largest single installation to date, for the Hardware Mutuals-Sentry Life property and casualty insurance group, employs thirty-six "Data-Phones." Four units equip the IBM data-processing centre at the Hardware Mutuals headquarters in Stevens Point, Wisconsin; the rest are in thirty-two regional offices from one end of the country to the other. The network, replacing the mails, among other things, will produce complete daily operating statements in seventeen minutes. Overall, it will reduce the customer-servicing time from two weeks to two days and save the group over 1,000,000 dollars annually in operating costs. The cost of "Data-Phone" is minimal. In addition to paying a set charge for the equipment, a customer pays for the line only as he uses it. "Data-Phone" can send information as slowly as seventy-five pulses or "bits" per second (roughly 100 words-a-minute) or as fast as 1200 bits-a-second (about 1600 words-a-minute).

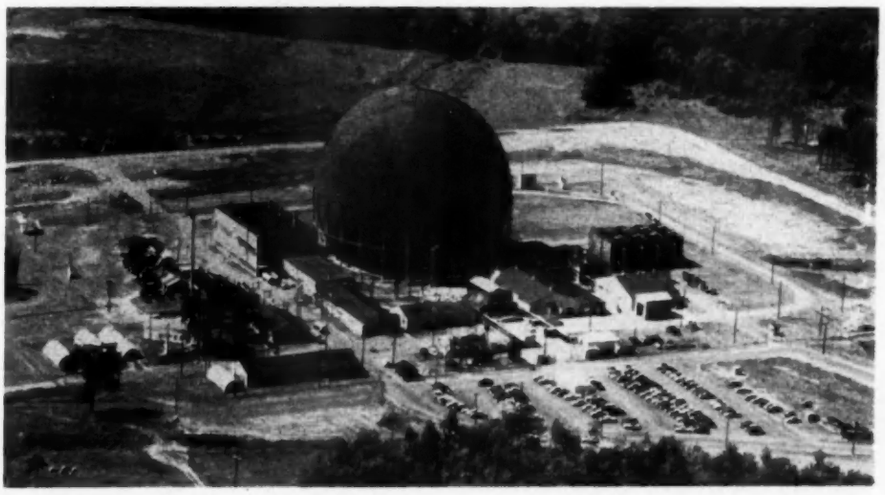
Evolutionary changes such as these have been given new impetus by two striking developments, both resulting from major policy decisions of the Federal Communications Commission. Last autumn, over the strenuous objections of all common carriers, the agency opened the channels of microwave to private users. Before this, only carriers and other regulated utilities could apply for such channels. The decision means that microwave equipment manufacturers can now connect intra-company networks independently of carriers like Western Union and A.T. & T. While the cost to the user of such an installation is immense—perhaps 4000 dollars per month just for amortisation of the terminals needed to cover a span of 100 miles—and thus hardly justifiable for any but large or at least widespread concerns, it nevertheless offers a direct challenge to the carriers' dominance of data communications in years ahead. A.T. & T., however, has been quick to counter the challenge with a radical innovation of its own. In February, the Federal Communications Commission conditionally approved the new service called Telpak (Telecommunications Package), the significance of which can be gauged by the fact that the microwave industry, through the Motorola concern, as well as Western Union, and virtually everyone else concerned, has protested against it. What Telpak does, is to provide through the wide-band facilities already available an economical package of all types of communications. For customers leasing anywhere from twelve to 240 telephone-type lines, Telpak offers a sizeable reduction in charges. Rates for Telpak units begin, at 15 dollars per mile per month for twelve lines, and range upward to 45 dollars per mile per month for 240, plus terminal charges according to the types of equipment used. By comparison, telephone-line rates for private-wire customers now are 3·50 dollars per mile per month, minus a discount for multiple channels. Thus A.T. & T. charges some 4000 dollars monthly for a 100-mile private wire system connecting, say, six voice channels, four facsimile units and a pair of teletypewriters. Under Telpak, the same set-up would cost 2160 dollars, and the savings are proportionately greater in the higher-volume Telpak channels. A customer who has found it economical only to lease five lines, including the cost of terminal equipment, now can have the full Telpak quota of twelve at no additional expense. Thus he might become a customer not only for more telephone or teletype service, but also for facsimile or computer communications. So severe are the Telpak reductions, and A.T. & T.'s initial interpretations of how the new service will work, that they appear to have seriously affected Western Union. The firm has filed a stern protest, the gist of which is that while Telpak may be all right as a "broad highway" linking major service centres, when interpreted to include many routes and inter-connections, it is a threat to any other private wire.

Whatever the ultimate decision on the future scope of Telpak, this much at least is clear: business communication is in the early stages of a total revolution.

Operation of Nuclear Power Plants of the U.S. Atomic Energy Commission

No. I

The Division of Reactor Development of the U.S. Atomic Energy Commission has released certain operating characteristics of its various power reactor plants installed in the United States. The information relates both to nuclear power stations and to experimental plants, and includes pressurised water reactors, boiling water reactors, organic cooled reactors and sodium-cooled reactors. Of particular interest are the data on everyday plant operating experience and on radiation intensities encountered during operating and maintenance periods.



THE operating experience obtained from reactors owned by the U.S. Atomic Energy Commission may be divided into the following two general categories: (1) technical information most useful to the design engineer; and (2) operating information most useful to the power station operator. The reactor experiments such as the Boiling Reactor Experiments (B.O.R.A.X.), the Organic Moderated Reactor Experiment (O.M.R.E.), the Experimental Breeder Reactor (E.B.R.), the Sodium Reactor Experiment (S.R.E.), &c., demonstrate the technical feasibility of a concept and provide the technical information necessary to design future plants. The demonstration and prototype reactors such as the U.S. Army Stationary Medium Power (SM-1) and Stationary Low Power (SL-1) plants, Shippingport, and, in the future, Elk River, Piqua, Hallam, &c., will develop information more useful to the reactor operator than the information from the reactor experiments which preceded these plants. Both reactors do, however, provide some information to both groups. The reactor experiments are directed more toward satisfying the needs of the design engineers while the prototype and demonstration reactors are directed more toward satisfying the needs of the utility operators.

It is important to note that since the prototypes do have a research and development programme associated with their operation, their operating experience may not be representative of that for a station operated solely as a power producer. For instance, the quantities of radioactive waste reported for SM-1, SL-1, Shippingport and the Experimental Boiling Water Reactor (E.B.W.R.) may be high because of the research and development and testing programme carried on with these plants. No operation and maintenance costs are presented here. The research and development, testing, and training programme associated with reactor operation makes it impossible to segregate the various costs and arrive at realistic figures for operation and maintenance costs.

More complete operating experience applicable to the operation of a nuclear central power station is available in the United States for the pressurised and boiling water concepts than for the other concepts. The Shippingport station has demonstrated that the pressurised water reactor concept is capable of operating as a base load or peak plant. The E.B.W.R. has demonstrated that a direct cycle boiling water reactor can be operated without undue activity at the turbine. Availability factors greater than

THE AMERICAN SCENE *(Continued)*

90 per cent have been obtained for both concepts. The sodium and organic cooled concepts are in the reactor experiment stage. However, demonstration plants of these concepts are under construction and will be in operation in the near future. Based on operating experience of reactor experiments, these concepts also appear to have the characteristics necessary for central power station use.

Maintenance experience has been obtained on all kinds of reactors ranging from instrument calibration to major repairs and modification in areas of high radiation levels. Novel techniques and special tools have been developed to perform many of the repairs. While these techniques and tools may not be adequate to handle every possible repair job that may arise in the future, the experience has demonstrated that major repairs can be made on radioactive systems. The manpower and time required for maintenance on the radioactive system is considerably higher than for similar maintenance work on conventional systems. This is especially so when the internal parts of the core or coolant system are exposed, permitting the spread of radioactive liquid and corrosion products.

The personnel radiation exposure levels have not exceeded the A.E.C. standards even though the level of activity in some areas requiring access has been quite high. The necessity to keep exposure levels to a minimum has led to the development of methods and techniques to confine the spread of contamination, to increase the effectiveness of manpower in highly radioactive areas, and to decontaminate radioactive equipment.

Radioactive waste, another problem area for nuclear plants, has been successfully handled and disposed of without any major technical difficulty. Liquid waste is normally diluted with condenser cooling water to an activity level of 10^{-7} or 10^{-8} microcuries per millilitre before discharging. Solid radioactive waste is packaged for off-site disposal. Radioactive gases are discharged to the atmosphere under controlled conditions.

WATER COOLED REACTORS

More experience has been obtained in the United States on light water cooled and moderated reactors than any other kind. Two reactor concepts, the pressurised water and boiling water, are included in this category and discussed here. Since meaningful data on the quantities and activities of radioactive waste produced by nuclear plants are available only for the pressurised and boiling water reactors, these data are summarised in Table I and discussed in more detail under each reactor. The waste quantities shown for one reactor are not necessarily comparable to those shown for another reactor because of differences in reactor type and size, different methods of processing the waste, and differences in operating, testing and training programmes. Because of the testing programme carried on at these plants, the waste quantities may not be representative for a nuclear power station.

SHIPPINGPORT PRESSURISED WATER REACTOR

The 60 MW(e) pressurised water reactor (Fig. 1) situated at Shippingport, Pennsylvania, achieved criticality on December 2, 1957. During the following two years, the plant operated a total of 5806 equivalent full power hours and generated 388,500,000kWh of electricity. On November 2, 1959, replacement of the first seed of the first core began. After five months of refuelling and one month of plant check-out and testing, the reactor was returned to full power operation on May 7, 1960. As of December 31, 1960, the plant had produced a total of 650,000,000kWh. Some of this operating experience is graphically presented in Fig. 2. Future plans include the installation of higher power density cores and modifying the plant to raise its power output to an equivalent of 150 MW(e).

The Shippingport station has demonstrated that the pressurised water reactor (PWR) concept is capable of operating on both a peak load and base load basis. The flexibility and load change response characteristics are superior to those of fossil-fuelled central station plants. As in the case with all reactor designs, the ability of the reactor to override transient xenon poison and take load swings is reduced as the core ages. However, during this period the reactor is still capable of operating as a base-load plant.

Since the reactor plant has four steam generating loops and is capable of full power operation with only three loops, the availability of the reactor plant was high in spite of problems with primary coolant pumps and steam generators. During the two years of operation with seed 1, there were some ninety interruptions. An interruption is defined by the Duquesne Light Company, who operates the station, as any occurrence which (*a*) results in loss of station output, (*b*) jeopardises personnel or equipment safety, (*c*) interferes drastically with plant operation, or (*d*) results in a safety shutdown. Of the ninety interruptions, twenty-three resulted in safety shutdown, twelve of them occurring during power operation and resulting in a loss of electrical output. The cause and number of safety shutdowns are summarised as follows :

Equipment-caused	8
Personnel error	15
Equipment design contributing	1
Test operating contributing	2
Maintenance contributing	2
Improper operation of test equipment	5
No contributing factor	5

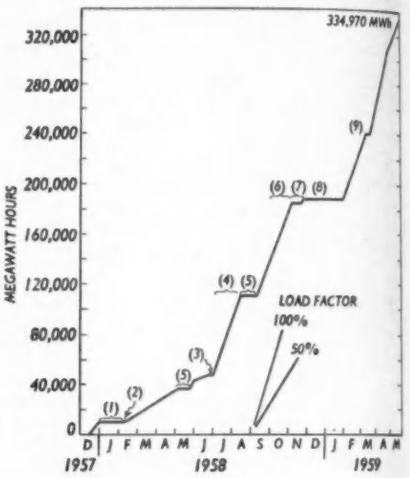
The number of safety shutdowns during the second year of operation decreased to about half the number occurring during the first year, with the ratio of personnel-to-equipment caused shutdowns remaining about the same. This decrease could be attributed to a better understanding of plant restrictions and increased familiarity with control circuitry.

Two major maintenance jobs involving the removal of a reactor coolant pump and volute and the inspection of heat exchangers for tube leaks were successfully completed. Both cases

TABLE I—*Summary of Waste from Pressurised and Boiling Water Reactors.*

	Liquid waste		Solid waste	Gas
	Gallons per MW(t)D	Microcuries per Millilitre[1]	ft³/MW(t)D	Curies per MW(t)D
Shippingport	32*	$1·3\times10^{-6}$*	5×10^{-3}†	—
SM-1	6	$1·4\times10^{-3}$	2×10^{-1}	—
EBWR	9	5×10^{-6}	3×10^{-2}	—
defective fuel	—	—	—	1×10^{-2}
SL-1	22	8×10^{-4}	6×10^{-1}	5×10^{-4}
instrumented fuel	—	—	—	0·5
				6·0

[1] For comparison purposes, the liquid waste activity is normally diluted to about 10^{-7} or 10^{-8} microcuries per millilitre with condenser cooling water before discharging.
* The non-active liquid waste and waste produced during the refuelling operations are not included.
† The volume of combustible material is reduced by incineration.



Explanations :
1—Reactor shutdown for testing and training.
2—Discovered leak in steam generator.
3—Reactor coolant pump failed.
4—First 1000 hour reactivity lifetime test.
5—Reactor shutdown for maintenance and testing.
6—Second 1000 hour reactivity lifetime test.
7—Reactor shutdown for maintenance and testing.
8—Moisture separator failure discovered ; plant remained shut down through January, 1959.
9—Repair of turbine governor.

Fig. 2—Operating experience of the Shippingport atomic power station

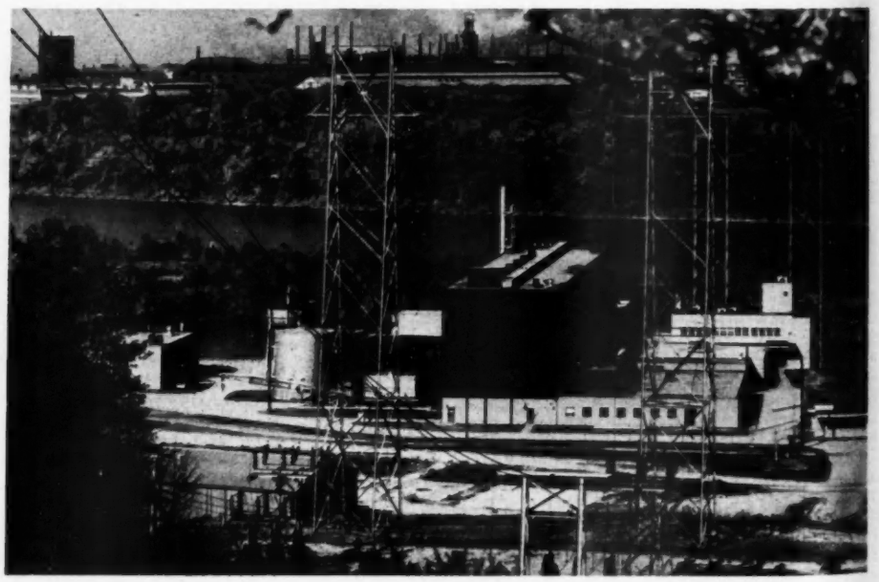


Fig. 1—60MW(e) Shippingport atomic power station operated by the Duquesne Light Company in Pennsylvania

required the rotation of personnel due to dosage accumulation. The radiation from the 18in pipe to and from the pump was about 25 mr per hour and the radiation level inside the heat exchanger was about 2·5 r per hour. In both cases, the actual mechanical maintenance job was minor compared with the problems created by the radioactivity. Many man-hours were spent in clean-up, shielding, precautionary measures to avoid or remove contamination, constant radiation control and personnel rotation. The pump required decontamination to less than 100 dpm per square ft beta-gamma, per smear sample, for return to the manufacturer for inspection and repair. This decontamination required two months. However, an ultrasonic decontaminating bath was later purchased for the refuelling operation which considerably reduced the time required.

Experience gained during operation and examination of components during refuelling has confirmed the high integrity of the core components including the fuel assemblies. The refuelling programme demonstrated that the "Failed Element Detection and Location" (F.E.D.A.L.) system makes it possible to locate fuel assemblies which develop defects during operation. The blanket assembly "F–2", which was suspected of having one or more defective fuel rods, was removed and replaced with a new blanket assembly. The reactor is designed to operate with failed fuel rods present in the core. Consequently, the replacement was done to demonstrate the feasibility of the F.E.D.A.L. system and not because of necessity.

Visual examination under water indicated no significant swelling or mechanical distortion of the seed assemblies. Peak burnup was about 68 per cent of U–235 or about 6×10^{20} atoms of U-235 fissioned per cubic centimetre of fuel alloy. Two blanket assemblies were dismantled for the replacement of a single bundle, and this operation was performed successfully with under-water equipment, thus demonstrating the flexibility of the blanket fuel assembly design. Sections of the blanket fuel examined indicated no distortion or fuel swelling and a maximum of 0·11 per cent fission product gas release within the fuel rod cladding. No grain growth was observed as a result of irradiation or high temperatures, indicating that the centre-line temperatures were less than 2650 deg. Fah. and that the heat flux during seed 1 operation was less than 300,000 B.Th.U. per hr–square ft. The burnup of UO_2 in the rod examined was approximately $1·77\times10^{20}$ fissions per cubic centimetre, which is about 7000 MWD per MT of natural uranium.

As a result of the high integrity of the fuel assemblies, the amount of radioactive material in waste discharged into the Ohio River was substantially less than originally anticipated. The waste disposal facilities are designed to collect, process and dispose of six classes of radioactive waste encountered in the operation. The permissible level of radioactivity, exclusive of tritium, in the liquid waste released to the Ohio River, is less than 10^{-8} microcuries per millilitre. The volumes and activities of liquid waste subsequent to any processing but prior to discharge to the turbine condenser effluent channel are presented in the table below. The rate of discharge of this waste into the turbine condenser effluent channel is controlled to dilute the waste by factors of 10^3 to 10^5, thereby limiting the level of radioactivity released to the Ohio River to less than 10^{-8} microcuries per millilitre. The total volume of gaseous waste discharged to the atmosphere from December 1957 to September 1959 was 5157 cubic feet containing 0·4 curie of radioactivity.

Solid waste consisting of incinerator ash, metal parts, asbestos, glass, tools, etc., is placed in 55 gallon drums, cemented, and shipped for sea burial. During the period from December, 1957 to September, 1959, approximately 146 drums were shipped or prepared for shipment.

The handling of the radioactive waste materials has been under excellent control, and the exposure levels have been comparatively low. Generally, the radiation levels during operation and shutdown have been lower than the design predictions. During the first few months of operation, the radiation intensities at full power showed a slight increase after which a steady state value was reached. On the other hand, the shutdown intensities, due almost entirely to the build up of corrosion products, have shown a steady rate of increase. The radiation intensities at various parts of the plant are summarised in Table III for full power operation, shutdown condition, and during refuelling operation.

TABLE II—*Volumes and activities of Liquid Waste at Shippingport*

	Average activity prior to dilution		
	Average gallons per day	Microcuries per day	Microcuries per millilitre
During normal operation :			
Non-active liquid waste	1830	5·7	8×10^{-7}
Special liquid waste	1270	28·2	$5·9\times10^{-6}$
Reactor plant liquid waste	1820	66·5	$9·6\times10^{-6}$
Chemical waste	151	4·5	$7·8\times10^{-6}$
During refuelling operation :			
Non-active liquid waste	2900	36	$3·3\times10^{-6}$
Special liquid waste	4300	1000	$6·1\times10^{-5}$

TABLE III—*Radiation Intensities at Shippingport*

	Intensities, mr per hour	
Full power operation :		
Contact with primary coolant loop inlet to heat exchanger	6000 to 14,000	
On walkways, 10ft above line	200	1000
In the auxiliary chamber	150	250
Purification valve access cubicles*	0·03	2
Pressuriser compartment	100	400
Shutdown :†		
Boiler chambers, general area	2	30
Heat exchangers on contact	—	200
Inside heat exchanger plenum	—	3000
Purification system regenerative heat exchanger	400	800
Reactor chamber	20	1200
Refuelling operation :		
Reactor pit :		
After removal of reactor chamber dome near refuelling seal	25	40
Inside rod drive mechanism array before installation of lead shield	375	1500
After installation of lead shield	25	600
After removal of position indicator coils, coil housing, stators, and water jacket assemblies on contact with motor tubes	1000	1500
At 1ft from motor tubes before shielding	—	500
At 1ft from motor tubes after shielding	—	250
At outer radius of refuelling seal	—	15
After cutting seal-weld and removal of mechanism motor and rotors :		
Just outside of mechanism array	70	180
At inner edge of seal ring	30	80
Near walls of reactor pit	7	10
During inspection of reactor vessel internals prior to cleaning and flooding for replacement of fuel assemblies:		
Over fuel ports	15	50
At seal ring	3	30
Radiation levels of removed components :		
Control rod drive mechanism rotors :		
Before decontamination—contact reading	150	2700
After decontamination at Shippingport‡	100	840
Mechanism motor guide tube	9	50
Thermal barriers	175	900
Seed metal-temperature thermocouples	180	230

* Accessible at all times.
† During the period August, 1958 to November, 1959, the intensities near the coolant piping increased by as much as six times and on the reactor head by a factor of about four which was due to deposit of activated corrosion products.
‡ An average decontamination factor of 5·3 was obtained with an ultrasonic cleaning technique.

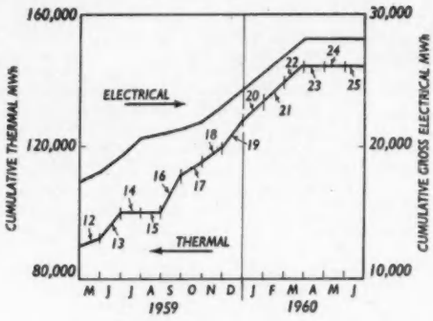
Fort Belvoir Pressurised Water Reactor

The Stationary Medium Power Plant No. 1 (SM–1), formerly known as the APPR–1, is a pressurised water reactor (Fig. 3) situated at Ft. Belvoir, Virginia, which generates about 1900kW(e) net. The fuel is fully enriched uranium in the form of UO_2 dispersed in stainless steel fuel plates. The first core for this reactor was installed in April 1957, and operated at

Fig. 3—1·9MW(e) Stationary Medium Power Plant No 1, formerly known as the Army Package Power Reactor, at Fort Belvoir in Virginia

Fig. 4—Severe "runaway" excursion test of the "Borax" reactor experiment in Idaho, with water and steam being ejected into the atmosphere

THE AMERICAN SCENE *(Continued)*



Major Shutdown Periods :
12—504 hours for core investigation, 54½ hours for maintenance.
13—20 hours for maintenance.
14—174 hours for maintenance, 113 hours for research and development.
15—9½ hours for maintenance, 552 hours for training and research and development.
16—95½ hours for maintenance, 197½ hours for training and research and development.
17—211½ hours for maintenance, 225·5 hours for training and research and development.
18—252½ hours for maintenance, 180 hours for training and research and development.
19—30 hours for maintenance and training, 271 hours for research and development.
20 and 21—Training and research and development.
22—Research and development activities.
23—Maintenance and research and development.
24 and 25—Research and development activities and rearrangement of Core 1.

Fig 5—Operating experience of the Stationary Medium Power Plant No. 1

approximately 50 per cent load factor. The reactor has been used principally to train military crews for power plant operation and as a source of reactor design information. The SM–1 has experienced no instability problems as demonstrated by results of operation during both planned and unplanned load changes. Typical operating experience is graphically presented in Fig. 5.

The plant was " on-line " producing power about 58 per cent of the time and was available for use about 91 per cent of the time. This availability factor could be increased by about 3 or 4 percentage points if maintenance were to be scheduled on a three-shift basis. The difference between 58 and 91 per cent was downtime for training and research and development. Of the 9 per cent downtime for maintenance, about 0·5 per cent was due to scrams. Over an eight month period in 1959 and 1960, a total of twenty-two unscheduled scrams occurred. Approximately one-third were due to operator error and two-thirds were due to equipment problems.

The handling of radioactive waste has not presented any major problems. Process water, which has a level of activity less than 1×10^{-7} microcuries per cubic centimetre, is discharged into the seal pit and then by gravity to Gunston Cove and the Potomac River. Water with an activity greater than this is temporarily stored in tanks and discharged under controlled conditions so that effluent water does not exceed 1×10^{-7} microcuries per cubic centimetre. An average of about 1000 gallons containing about 5000 microcuries is discharged into the Potomac River from the waste tanks per month. Solid waste material, except for the exhausted demineraliser, is packaged and sent to an outside contractor for disposal. Over an eight-month period, the volume of waste has averaged about five drums of 55 gallons per month.

In general, most equipment maintenance and servicing outside the vapour container can be performed while the plant is in operation, especially where duplicate equipment exists. The operation of the plant has demonstrated the advisability of reducing to a minimum the equipment in the vapour container that requires servicing at times other than during fuel changes. During the period from March 7 to May 17, 1959, the reactor vessel head was removed for core inspection. The mechanical components of the reactor vessel and core structure were found to be broken, requiring approximately 560 man hours to remove the broken studs and other studs for examination. The operation demonstrated the feasibility of performing maintenance problems of this nature under radiation conditions. The radioactivity of the shield tank water was $3\cdot0\times10^{-7}$ microcuries per cubic centimetre prior to removal of the reactor pressure vessel head. The activity of the shield tank reached $7\cdot0\times10^{-2}$ microcuries per cubic centimetre within about 15 minutes with the intermixing of primary water when the reactor head was removed. Additional activity increase was caused by the disturbance of large quantities of crud when the core elements were moved. There was a direct correlation of activity level of the shield tank and dose rates at the railing surrounding the shield tank. The maximum dose rate observed was 360 mr per hour when the shield tank water reached a level of $1\cdot33\times10^{-1}$ microcuries per cubic centimetre. The continuous circulation of the shield tank water through a demineraliser kept the dose rates at the hand rail below 35 mr per hour.

Based on the operation and maintenance experience at Fort Belvoir, it is estimated that a crew of about sixteen members, as described in Table IV, could operate plants of this type at remote sites.

TABLE IV—*Operating Crew for a Small P.W.R.*

Description	No. of people
Officer in charge	1
Superintendent of plant	1
Assistant superintendent and maintenance supervisor	1
Shift supervisor	4
Control room and equipment operator	4
Mechanical maintenance technicians	2
Electrician	1
Instrument technician	1
Health physics and chemistry technician	1
Total	16

Borax Boiling Water Reactors

The feasibility of the boiling water concept was first demonstrated in the United States in a series of reactors known as the " Borax " reactors (Boiling Reactor Experiment). " Borax "–I, constructed at the National Reactor Testing Station at Idaho, in 1952, was basically an experimental tool to test the feasibility of the boiling water concept and check the inherent shutdown mechanism due to void formation. During the short life span of about a year in 1953 and 1954, a large number of excursion tests and a small number of steady state boiling experiments were run. A final experiment was made by adding about 4 per cent k_{eff} in 0·2 second which resulted in the planned self-destruction of " Borax "–I (Fig. 4).

" Borax "–II was similar to " Borax "–I but had a core about twice as big and a pressure vessel for operating at 300 lb per square inch gauge. The fuel elements were again U–Al alloy clad with aluminium. The primary object of the " Borax "–II was to study natural circulation at higher pressures. Tests similar to those conducted on " Borax "–I were made at atmospheric pressure and at 300 lb per square inch gauge. Tests were also conducted with this reactor to determine its response when the main steam valve was closed suddenly and when the safety valves opened suddenly. Because of the stable reactor behaviour during these tests, it was decided to install a turbo-generator plant. With the addition of the turbo-generator and new fuel elements, the reactor became " Borax "–III.

The main purpose of " Borax "–III was to study the operation of a boiling water reactor as a component in a power generation system. The reactor plant operated stably at all pressures from atmospheric to 300 lb per square inch gauge. It operated at maximum power levels of 16 MW(t) and 3·5 MW(e) and was the first boiling water reactor to generate electric power.

" Borax "–IV was the " Borax "–III reactor with a new core consisting of ThO_2-UO_2 fuel canned in aluminium and bonded with lead. The primary emphasis in the experimental programme of this reactor was to obtain more detailed data on the stability and safety of boiling water reactors. In addition to the steady state and transient operating data, " Borax "–IV provided information on radiolytic decomposition rates of water and data on the contamination of the reactor coolant loop due to fuel cladding failures. These failures were detected in February, 1958, by the sudden increase in activity in the turbine room to 70 mr per hour. The activity levels increased to 400 mr per hour in the turbine room and 8000 mr per hour in the hot well following further reactor operation with the failed fuel elements. An examination of the fuel elements later indicated that at least seventeen elements had failed. These failures were attributed to leaks caused by the collapse of the aluminium into the void space above the oxide pellets after repeated thermal cycling. It is important to note that operation with the failed fuel elements, although causing a relatively high activity level in the plant during operation, caused no significant contamination of the turbine and little increase in the gross activity of the water.

Surface activities at various points in the plant were measured while the reactor operated with the failed fuel elements. The results of these measurements are shown in Table V for various operating powers and for 17 hours after shutdown.

The operating experience of " Borax "–III and " Borax "–IV is shown graphically in Fig. 6. " Borax "–IV was shut down in 1958 for modification to " Borax "–V which is expected to achieve criticality shortly.

(To be concluded)

Shut Down Periods :
1—Plant revisions and zero power tests.
2—Plant revisions.
3—General maintenance.
4—Modification to " Borax "-IV and, subsequent zero power tests.
5—Reactor stability tests.
6—Shielding modification.
7—Examinations and tests following fuel element failure.
8—Shut down pending modification to " Borax "-V.

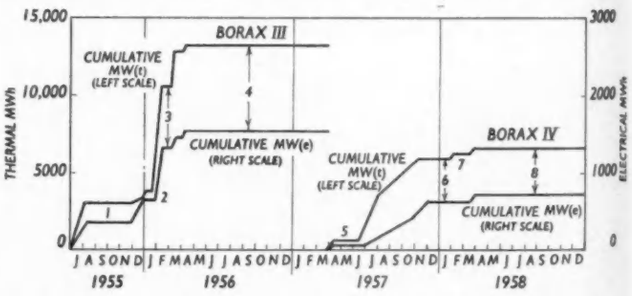


Fig 6—Operating experience of the " Borax "-III and " Borax "-IV reactor experiments

TABLE V—" *Borax "-IV Surface Activities in Mr per hour During Operation with Fuel Defect*

	Before operation	2·4 MW (thermal)	6·0 MW (thermal)	17 hours after shutdown	Normal activities at 12 MW (thermal)
Steam pipe turbine building	0	250	400	0	200
Turbine exhaust casing (external)	0	150	190	0	50
Turbine exhaust casing—gamma	0·7	—	—	0·7	—
(Internal)—beta + gamma	15	—	—	15	—
Condenser hotwell	0	2,200	5,000	1·5	500
Air ejector after-cooler	0	15,000	—	0	420
Air ejector discharge	0	30,000	50,000	1	—

BRITISH PATENT SPECIFICATIONS

The dates printed are those of application and publication on completion. Copies of specifications may be obtained at the Patent Office Sales Branch, Southampton Buildings, Chancery Lane, W.C.2, 3s. 6d. each

DIESEL-ELECTRIC TRACTION

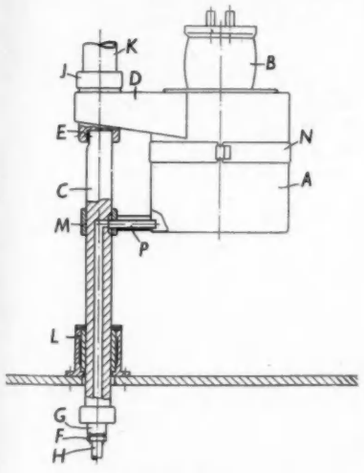
877,663. June 23, 1960.—DIESEL-ELECTRIC LOCOMOTIVES, Manfred Behr, trading as Süddeutsche Kühlerfabrik Julius Fr.Behr, 5, Mauserstrasse, Stuttgart-Feuerbach, Germany.

This invention concerns improvements relating to diesel-electric locomotives and more particularly to the cooling air arrangements. The specification describes a means for controlling automatically the louvres admitting cooling air to the braking resistors. These louvres are operated by an hydraulic system which also drives the radiator fan and governs the opening or closing of the radiator louvres. When the driver moves his controller from power to brake, it operates a valve in the hydraulic system which causes the resistance cooling louvres to open. At the same time the radiator louvres are closed by the action of a spring, so that the engine cooling water temperature is not reduced undesirably. On the change to braking, there is a short delay in the opening of the resistance cooling louvres, during which the radiator louvres are open until the thermostat in the cooling water circuit detects the fall in temperature and initiates closure, at the same time controlling the speed of the fan motor as desired.—*September* 20, 1961.

TELECOMMUNICATIONS

879,362. August 5, 1959.—COOLING ARRANGEMENTS FOR POWER VALVES, Siemens and Halske Aktiengesellschaft, Munich, Germany.

It is an object of this invention to provide an improved cooling arrangement by which quick and safe exchange of heavy, high-power radio valves is made possible even under conditions of restricted space. The cooling pot can be swivelled from an operative position in, say, the cabinet of a transmitter, into a non-operative position where there are no other components restricting space and where an attendant can conveniently and safely change or service the valve. When the cooling pots are swivelled in this manner the supply lines for the coolants need not be dismantled, so that deleterious effects on adjacent components by leaking coolant are prevented. Referring to the embodiment illustrated, a cooling pot *A* carrying a high-power valve *B* is rigidly connected to a supporting member *C* by means of a hollow arm *D*. A flat portion *E* on the supporting member ensures that this member and the cooling



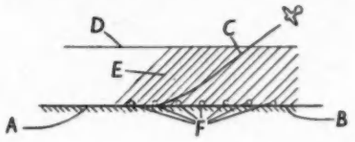
No. 879,362

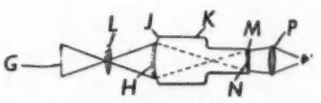
pot *A* are always in a fixed relationship. Screw flange *F* is coupled to rotatable fluid-seal *G* and to the coolant fixed input supply tube *H*. Screw flange *J* is similarly coupled to rotatable fluid seals connected both to the hollow arm *D* and a fixed output supply line *K*. The flow of coolant from the fixed input supply line to the output supply line through the cooling pot is unrestricted whatever the relative positions of the supporting member and the fixed supply line. The minimum spacing between the bearing *L* and a lower fixing point *M* for the cooling pot depends upon the anode voltage employed. A quick-release strap *N* is adapted to hold the cooling pot in the operative position and serves also as the electrical connection to a tuned circuit. Supporting member *C* together with the coolant therein forms a fluid or water resistor. For feeding the coolant from the supporting member to the cooling pot a tube *P* is provided which is arranged so that it can be pushed into the cooling pot. The rotatable seals may readily be exchanged without dismantling the remaining parts of the arrangement.—*October* 11, 1961.

ELECTRONICS

879,916. July 10, 1959.—AIRCRAFT LANDING SYSTEM, Nippon Electric Company Ltd., 2, Shiba Mita Shikoku-machi, Minato-ku, Tokyo, Japan.

This invention provides a safe landing system in a fog by use of infra-red radiation. The principle resides in arranging a large number of infra-red radiating objects capable of producing heat on the ground to despatch or rarefy the fog by use of the heat, and in enabling the pilot to observe the radiating objects on the ground through a noctovision device mounted on the aircraft. In the upper drawing an aircraft is about to land on a runway, *A* and *B*. The path followed by the aircraft prior to landing is represented by *C*. After the aircraft has reached an altitude of 80m above the airfield by the guidance of a radio beacon or an instrument landing system located at *D*, the pilot is compelled to complete a landing by observing the runway surface with the naked eye. Oblique lines *E* indicate fog. The horizontal distance that is necessary for the aircraft before it comes to a stop on the runway from an altitude of 80m is estimated at about 2000m. An advantage of using the infra-red ray is the fact that heat is safely and easily radiated. A fog may easily be dissipated or evaporated upon encountering such heat. In the drawing, *F* denotes the infra-red radiators installed along part of the runway and the surface of the route of an aircraft covering a range of from 500m to 2000m. The radiators consist of infra-red lamps with reflectors, which are necessary for maximum utilisation of heat. A second advantage of the use of infra-red radiation is the fact that rays which cannot penetrate a dense fog formed by particles of large diameter, can easily penetrate through a fog, a haze, or smoke formed by particles of small diameter.





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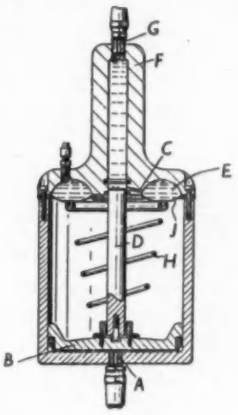
The infra-red radiation cannot be seen with the naked eye. This is made possible by the noctovision device (lower drawing) wherein the infra-red ray emitted from an object *G* forms an image *H* on the photoelectric surface *J* in the image tube *K* through an objective lens *L*. The photoelectrons liberated from the photoelectric surface depend on the lights and shades of the image. These photoelectrons are accelerated and focused by the electrodes within the image tube, causing the fluorescent screen *M* to fluoresce, and a visible image *N* to form thereon. Although the image is inverted by the objective lens *L* it is again inverted within the image tube. It is observed by a magnifying eyepiece *P*. The effective wavelengths of the image tube cover from 0·4 to 1·2 microns, extending appreciably into the infra-red region of the spectrum as compared with the visible range of spectrum covering from 0·4 to 0·7 microns. The rays emitted from an infra-red lamp contain abundantly the rays having wavelengths of the order of 1 micron, which can be well observed by the above-mentioned apparatus. Most of the light emitted by an ordinary electric lamp is infra-red, the proportion occupied by the visible rays being extremely small. Consequently, by the use of the infra-red noctovision apparatus, the infra-red portion of the spectrum can be fully utilised as if the light were amplified. For example, when an object at a temperature of 1000 deg. K is observed, it is seen as if it were several hundred times as bright as when observed with the naked eye. Tests have shown that the image available from the noctovision apparatus has sharp contrast. Visible rays are apt to be diffused by particles suspended in air, the contrast being deteriorated notably where the light is incident on the object sideways. On the contrary, infra-red rays are less diffused. As a result, a distant view is clearly observed with the aid of noctovision apparatus even in cases where it is difficult to see with the naked eye or by binoculars. A third advantage of utilising the infra-red ray is that no glare is felt as is the case with ordinary light sources.—*October* 11, 1961.

HYDRAULIC EQUIPMENT

879,825. July 20, 1960.—PRESSURE-MULTIPLYING DEVICES, Amp Incorporated, Eisenhower Boulevard, Harrisburg, State of Pennsylvania, U.S.A.

This invention relates to pressure-multiplying devices or intensifiers comprising a low pressure pneumatic cylinder containing a piston with a plunger extending into a high pressure hydraulic cylinder. In such intensifiers, as in other hydraulic devices, there is inevitably some loss of hydraulic fluid by leakage at the couplings and although the amount of fluid lost may be extremely small for each stroke, the accumulated losses can seriously deplete the hydraulic fluid so that the work which can be obtained will be substantially reduced. This invention is designed to avoid the effects of such losses, and the form is shown in the accompanying drawing.



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In use air is admitted through the inlet *A* against the piston *B* to advance it. Upon initial movement of the piston, passage *C* is closed by the plunger *D* and communication between the reservoir *E* formed by a diaphragm *J* at the top of the air cylinder and the hydraulic cylinder *F* is interrupted. Upon further movement the fluid within the cylinder *F* is supplied under high pressure through the outlet *G*. After the air has been exhausted at the end of the stroke, the spring *H* returns the piston to its retracted position thus uncovering the passage *C*. The pressure imposed by the spring on the diaphragm forces hydraulic fluid from the reservoir into the cylinder *F* which is thus at all times maintained at the maximum level and any loss of fluid in the system is compensated for on each stroke.—*October* 11, 1961.

EARTH MOVING EQUIPMENT

878,807. January 22, 1960.—SOIL-MOVING MACHINE, Société Auxiliaire de l'Entreprise (Auxen), 20, rue Vernier, Paris, France.

This soil moving machine has a bucket which is vibrated in use so that when driven into soil it breaks down the structure. Three hydraulic vibrators are mounted on the bucket and when it is pushed against soil it is vibrated in its direction of travel. The vibrators are connected to a common control valve and hydraulic power for their operation is supplied by a variable displacement pump driven by the engine. The frequency of vibration can be varied by varying the displacement of the pump. The vibrators act directly on the bucket and their action on the arms and the struts of the machine is checked by resilient bushes or connections of rubber or similar material. When the bucket is full the vibrators can be turned on again when emptying so that detachment of adhering soil is facilitated.—*October* 4 1961.

Forthcoming Engagements

Secretaries of Institutions, Societies, &c., desirous of having notices of meetings inserted in this column are requested to note that, in order to make sure of their insertion, the necessary information should reach this office not later than a fortnight before the meeting. In all cases the TIME *and* PLACE *at which the meeting is to be held should be clearly stated.*

ASSOCIATION OF SUPERVISING ELECTRICAL ENGINEERS

Sat., Nov. 18.—NORTH LONDON BRANCH: Visit to Guinness Brewery, Park Royal, 2.30 p.m.

Mon., Nov. 20.—BRISTOL AND WEST OF ENGLAND BRANCH: Grand Hotel, Bristol, "Principles of Radio and Television Communication," R. E. Griffin, 8 p.m. ★ MID-ESSEX BRANCH: White Hart Hotel, Tindal Street, Chelmsford, "The Aims and Objects of the Electrical Association for Women," Mrs. S. T. Gunstone, 7.45 p.m.

Tues., Nov. 21.—PORTSMOUTH AND DISTRICT BRANCH: H.M.S. "Collingwood," Fareham, Hants, "Safety in the Utilisation of Electricity," S. J. Emerson, 7.30 p.m. ★ WEST KENT BRANCH: Rose and Crown Hotel, Tonbridge, "Electricity on the Dairy Farm," P. Wakeford, 7.30 p.m.

Thurs., Nov. 23.—SOUTH LONDON BRANCH: Greyhound Hotel, Croydon, Surrey, "The National Inspection Council for Electrical Installation Contracting," E. J. Sutton, 8 p.m. ★ NOTTINGHAM BRANCH: People's College of Further Education, Castle Road, Nottingham, "Plastics in the Electrical Industry," A. J. Moulam, 7.30 p.m. ★ SOUTHAMPTON BRANCH: Polygon Hotel, Southampton, "Electric Water Heating," 8 p.m.

Fri., Nov. 24.—COVENTRY AND DISTRICT BRANCH: Conservative Rooms, 16, Queens Road, Coventry, "Industrial Motor Control Gear," B. Bardell, 8 p.m. ★ OXFORD AND DISTRICTS BRANCH: Technical College, Walton Road, Aylesbury, "Power Factor Correction," T. A. Williams, and film, "Capacitors Pay Dividends," 7.30 p.m. ★ STOKE AND CREWE BRANCH: Grand Hotel, Hanley, "Temperature Control," L. Clarke, 7.30 p.m.

BRITISH INSTITUTION OF RADIO ENGINEERS

Wed., Nov. 22.—COMPUTER GROUP: London School of Hygiene and Tropical Medicine, Keppel Street, Gower Street, London, W.C.1, Symposium on "Adaptive Optimising Control," 6 p.m.

Thurs., Nov. 23.—WEST MIDLANDS SECTION: Electrical Engineering Dept., The University, Birmingham, "Tunnel Diodes," K. Hulme, 6.15 p.m.

BRITISH INTERPLANETARY SOCIETY

Wed., Nov. 22.—Lecture Theatre, Royal Aeronautical Society, 4, Hamilton Place, London, W.1, Symposium on "Materials in Space Technology," 9.30 a.m.

CEMENT AND CONCRETE ASSOCIATION

Mon., Nov. 20.—Highbury Technical College, Angelsea Road, Portsmouth, "New Techniques in Building," D. Bishop, 7.15 p.m.

Tues., Nov. 21.—Technical College, St. Mary Street, Southampton, "The Fire Resistance of Concrete Structures," M. R. Hollington, 7.15 p.m.

Mon., Nov. 27.—College of Further Education, High Wycombe, Bucks., "Essentials of Good Concreting," E. E. H. Bate, 7.15 p.m.

COMBUSTION ENGINEERING ASSOCIATION

Tues., Nov. 21.—SOUTHERN REGION: Criterion Restaurant, Piccadilly Circus, London, W.1, Discussion on "Coal Handling From Store to Boiler," opened by F. S. Stent, 10.30 a.m.

ILLUMINATING ENGINEERING SOCIETY

Mon., Nov. 20.—LEEDS CENTRE: British Lighting Council, 24, Aire Street, Leeds, 1, "Continental Lighting Practice," A. W. Gostt, 6.15 p.m.

Tues., Nov. 21.—LIVERPOOL CENTRE: Industrial Development Centre, Paradise Street, Liverpool, "Office Lighting," R. G. Hopkinson and J. Longmore, 6 p.m. ★ NORTH LANCASHIRE GROUP: Demonstration Theatre, N.W. Electricity Board, 19, Friargate, Preston, "The New I.E.S. Code," W. Robinson, 6.30 p.m.

Mon., Nov. 27.—BIRMINGHAM CENTRE: Chamber of Commerce, 75, Harborne Road, Edgbaston, Birmingham, 15, "Lighting of Large Office Buildings," J. H. D. Madin, 6.30 p.m.

INSTITUTE OF BRITISH FOUNDRYMEN

Tues., Nov. 21.—EAST ANGLIAN SECTION: Lecture Theatre, Ipswich Civic College, Rope Walk, Ipswich, "Introduction to the Manufacture of Malleable Iron Chain," R. Leeks, 7.30 p.m.

Thurs., Nov. 23.—LONDON BRANCH: National Liberal Club Whitehall Place, London, S.W.1, "Are New Corebinders Worthwhile in a Jobbing Foundry," E. H. Beech, 7.30 p.m.

INSTITUTE OF MARINE ENGINEERS

To-day, Nov. 17.—SCOTTISH SECTION: Robert Gordon's Technical College, Aberdeen, Joint meeting with the Aberdeen Mechanical Society, "Elementary Nuclear Engineering," H. F. Close, 7.30 p.m.

Mon., Nov. 20.—SOUTH WALES SECTION: South Wales Institute of Engineers, Park Place, Cardiff, "Marine Machinery Breakdowns," to be read by J. H. Milton, 6 p.m.

Tues., Nov. 21.—SOUTHERN JOINT BRANCH: Royal Beach Hotel, South Parade, Southsea, Joint meeting with the Royal Institution of Naval Architects, "The Effect of Cavitation on Propeller Efficiency," R. N. Newton, 7.30 p.m.

Thurs., Nov. 23.—MERSEYSIDE AND NORTH WESTERN SECTION: Lecture Theatre, Abbey Road Technical College, Barrow-in-Furness, "The Closed Feed System," T. O. Leith, 7.30 p.m. ★ JUNIOR LECTURE: Hendon Technical College, The Burroughs, Hendon, London, N.W.4, "Auxiliaries," P. Scorer, 6.15 p.m.

INSTITUTE OF METALS

Mon., Nov. 20.—NORTH EAST METALLURGICAL SOCIETY: Cleveland Scientific and Technical Institution, Corporation Road, Middlesbrough, "Recent Advances in the Foundry," A. T. Andrew, 7.30 p.m.

Wed., Nov. 22.—MANCHESTER METALLURIGCAL SOCIETY: Manchester Literary and Philosophical Society, George Street, Manchester, "Metallurgy of the Rarer Metals," J. C. Chaston, 6.30 p.m.

Thurs., Nov. 23.—BIRMINGHAM LOCAL SECTION: College of Advanced Technology, Gosta Green, Birmingham, "The Cold Extrusion of Steel," R. W. A. Wright, 6.30 p.m. ★ SHEFFIELD LOCAL SECTION: Applied Science Building, The University, St. George's Square, Sheffield, Symposium on "Inclusions in Metals," 2 p.m. ★ SOUTHAMPTON METALLURGICAL SOCIETY: The University Southampton "Electro-Plating Processes: Effect on Fatigue Strength and Embrittlement of the Substrata," C. Williams, 7.15 p.m.

INSTITUTE OF NAVIGATION

To-day, Nov. 17.—Royal Institution of Naval Architects, 10, Upper Belgrave Street, London, S.W.1, "The Navigation and Guidance of Supersonic Aircraft," William L. Polnemus, 5.30 p.m.

INSTITUTE OF PHYSICS AND THE PHYSICAL SOCIETY

Mon., Nov. 20.—MANCHESTER AND DISTRICT BRANCH: College of Science and Technology, Manchester, "Neutron Diffraction," G. E. Bacon, 7 p.m.

INSTITUTION OF CHEMICAL ENGINEERS

Fri., Nov. 24.—SCOTTISH BRANCH: Lea Park Tea Rooms, Falkirk, "Absorption on the Surface of a Sphere," G. Stewart, 7.30 p.m.

INSTITUTION OF CIVIL ENGINEERS

Tues., Nov. 21.—Great George Street, Westminster, London, S.W.1, "The Main Building for the 7 GeV Proton Synchrotron at Harwell," S. A. Rossiter and J. S. Brown, 5.30 p.m.

Thurs., Nov. 23.—Great George Street, Westminster, London, S.W.1, Informal Discussion on "Freight Handling," introduced by E. C. Engledew and R. F. Stoessel, 5.30 p.m.

INSTITUTION OF ELECTRICAL ENGINEERS

To-day, Nov. 17.—NORTH EASTERN GRADUATE AND STUDENT SECTION: Grey Hall, King's College, Newcastle upon Tyne, "The Transient Performance of the Synchronous Generator," M. W. Kennedy, 6.30 p.m.

Sat., Nov. 18.—LONDON GRADUATE AND STUDENT SECTION: Visit to Arthur Guinness, Son and Co. (Park Royal) Ltd., 10.30 a.m.

Mon., Nov. 20.—INFORMAL MEETING: Savoy Place, London, W.C.2, Discussion on "Electrical Accidents and their Causes, including the Legal Aspects," opened by S. J. Emerson, 5.30 p.m. ★ LONDON GRADUATE AND STUDENT SECTION: Arborfield District: Unit Cinema, 3 (Tels.) Training Bn., R.E.M.E., Arborfield, Berks., "History of Modern Television," A. D. G. Wheatley, 7 p.m. ★ EAST MIDLAND ELECTRONICS AND CONTROL GROUP: Swan Hotel, Bedford, "Some Recent Advances in Semiconductor Circuits," G. B. B. Chaplin, 7 p.m ★ MERSEY AND NORTH WALES CENTRE: Town Hall, Chester, "Transistors," P. Godfrey, 6.30 p.m. ★ NORTH-EASTERN MEASUREMENT AND ELECTRONICS GROUP: Rutherford College of Technology, Northumberland Road, Newcastle upon Tyne, "Simulation of Intelligence," D. M. Mackay, 6.15 p.m. ★ NORTH-WESTERN CENTRE: Education Discussion Circle: Electrical Engineering Laboratories, The University, Manchester, Discussion on "Exchange of Ideas on Laboratory Experiments," 6.15 p.m. ★ WESTERN SUPPLY GROUP: Demonstration Theatre, Electricity House, Colston Avenue, Bristol, "The Manufacture, Properties and Use of Some of the New Insulation Materials for the Electrical Industry," K. Pollard, 6 p.m. ★ SHEFFIELD SUB-CENTRE: Angel Hotel, Brigg, "A General Theory of Depreciation of Engineering Plant," D. Rudd, 6.30 p.m.

Tues., Nov. 21.—MEASUREMENT AND CONTROL SECTION: Savoy Place, London, W.C.2, Discussion on "The Precision Required in the Calibration of Industrial Instruments," opened by P. M. Clifford and A. Felton, 5.30 p.m. ★ NORTH MIDLAND UTILISATION GROUP: Leeds and County Conservative Club, South Parade, Leeds, 1, "A Survey of Street Lighting and its Future," W. R. Stevens and H. M. Ferguson, 6.30 p.m. ★ NORTH-WESTERN MEASUREMENT AND CONTROL GROUP: Engineers' Club, Albert Square, Manchester, "Transistor Instrumentation in Rockets," G. G. Haigh, 6.15 p.m. ★ SOUTHERN ELECTRONICS AND CONTROL GROUP: C.E.G.B. Offices, High Street, Portsmouth, "The Application of Electrical Phenomena at Liquid Helium Temperatures," R. E. Haves, 6.30 p.m. ★ WESTERN CENTRE: Colston Hall, Bristol, Faraday Lecture "Expanding Horizons in Communications," D. A. Barron, 6.30 p.m.

Wed., Nov. 22.—SUPPLY SECTION: Savoy Place, London, W.C.2, "Electronic Analogue Computer Simulation of Multi-Machine Power System Networks," A. S. Aldred, and "Analysis of Overall Stability of Multi-Machine Power Systems," J. G. Miles, 5.30 p.m. ★ LONDON GRADUATE AND STUDENT SECTION: Visit to Hackbridge and Hewittic Electric Company Ltd., Transformer and Rectifier Sections, 2 p.m. ★ CAMBRIDGE ELECTRONICS AND MEASUREMENT GROUP: Engineering Department, Cambridge University, Trumpington Street, Cambridge, "Recording of High Speed Phenomena," C. W. B. Grigson, 6 p.m. ★ SOUTH MIDLAND CENTRE: Midland Institute, Paradise Street, Birmingham, "Experimental Investigation of Space," J. A. Ratcliffe, 6.30 p.m. ★ SOUTHERN CENTRE: Abbey House, Winchester, "Construction, Operation and Maintenance at 132kV and 275kV Overhead Grid Lines," J. A. Wakefield and H. G. New, 6.30 p.m.

Thurs., Nov. 23.—EDUCATION DISCUSSION CIRCLE: Savoy Place, London, W.C.2, Discussion on "The 57 Effects of an Electrical Current," opened by G. S. Brosan, 6 p.m. ★ WESTERN CENTRE: Sophia Gardens Pavilion, Cardiff, Faraday Lecture, "Expanding Horizons in Communications," D. A. Barron, 6.45 p.m.

Fri., Nov. 24.—SOUTH MIDLAND CENTRE EDUCATION DISCUSSION CIRCLE: College of Technology, Gosta Green, Birmingham, "A Materials Course for Electrical Engineers," G. T. Wright, 6.15 p.m.

Mon., Nov. 27.—NORTH-EASTERN CENTRE: Neville Hall, Westgate Road, Newcastle upon Tyne, "The Place of Formal Study in the Post-Graduate Training of an Electrical Engineer," N. N. Hancock and P. L. Taylor, 6.15 p.m. ★ SOUTH MIDLAND ELECTRONICS AND MEASUREMENT GROUP: James Watt Memorial Institute, Birmingham, "Electronics in the Electric Supply Industry," J. S. Forrest, 6 p.m. ★ NORTH STAFFORDSHIRE SUB-CENTRE: Mechanics Institute, Crewe, "Electric Traction," J. A. Broughall, 7 p.m. ★ WESTERN UTILISATION GROUP: South Wales Institute of Engineers, Cardiff, "Silicone Electrical Insulation," J. H. Davis, 6 p.m.

INSTITUTION OF ENGINEERS AND SHIPBUILDERS IN SCOTLAND

Tues., Nov. 21.—39, Elmbank Crescent, Glasgow, "Lloyd's Rules for Electrical Equipment of Ships—Some Underlying Considerations," D. Gray, 6.30 p.m.

Fri., Nov. 24.—Technical College, Dundee, Joint meeting with Dundee Institute of Engineers, "The Atom in the Future," W. R. Wootton, 7.30 p.m.

INSTITUTION OF HEATING AND VENTILATING ENGINEERS

Mon., Nov. 20.—LIVERPOOL AND DISTRICT BRANCH: Exchange Hotel, Tithebarn Street, Liverpool, "The Importance of the Heating Engineer to the Architect," 6.30 p.m.

Tues., Nov. 21.—SCOTTISH BRANCH: 25, Charlotte Square, Edinburgh, "The Heating and Ventilating of Coventry Cathedral," A. F. Myers, 7 p.m.

INSTITUTION OF HIGHWAY ENGINEERS

Tues., Nov. 21.—NORTHERN BRANCH: Battersby Hall, Keswick, "Modern Maintenance, with particular reference to Motorways," 7 p.m.

INSTITUTION OF LOCOMOTIVE ENGINEERS

Thurs., Nov. 23.—Lecture Hall, Institution of Mechanical Engineers, 1, Birdcage Walk, Westminster, London, S.W.1, "Some Problems in Vehicle Riding," E. S. Cox, 5.30 p.m.

INSTITUTION OF MECHANICAL ENGINEERS

To-day, Nov. 17.—LONDON GRADUATES' SECTION: Technical College, Queensway, Enfield, "Recent Developments in L.T.E. Railway Rolling Stock Design," G. Styles, 7.15 p.m.

Sat., Nov. 18.—SOUTHERN GRADUATES' SECTION: Visit to Diagrit Grinding Company, Station Road, Staplehurst, near Tonbridge, Kent, 10.30 a.m. ★ SOUTHERN GRADUATES' SECTION: Visit to Deverish and Groves Ltd., Brewery, Trinity Street, Weymouth, 10 a.m.

Mon., Nov. 20.—INDUSTRIAL ADMINISTRATION AND ENGINEERING PRODUCTION GROUP: 1, Birdcage Walk, Westminster, London, S.W.1, Discussion on "Mechanical Handling of Small Parts with Special Reference to Automatic Assembling Equipment," 6 p.m. ★ SCOTTISH A.D. CENTRE: Institution of Engineers and Shipbuilders, 39, Elmbank Crescent, Glasgow, C.2, "The Rolls-Royce Car," S. H. Grylls, 7.30 p.m. ★ YORKSHIRE BRANCH: Institute of Technology, Bradford, "Heat Accumulators in Industry," W. Goldstern, 7.15 p.m. ★ DERBY A.D. CENTRE: Midland Hotel, Derby, "The Importance of the Design Stage," D. Baston, 7.30 p.m.

Tues., Nov. 21.—NORTHERN IRELAND BRANCH: Central Technical College of Technology, Belfast, Repetition of James Clayton Lecture, "Machine Tool Research, Design and Utilisation," D. F. Galloway, 6.30 p.m. ★ COVENTRY GRADUATES' ASSOCIATE CENTRE: Grosvenor Room, Hotel Leofric, Coventry, "The Wankel Engine," A. Stevens, 7.30 p.m. ★ LONDON GRADUATES' SECTION: 1, Birdcage Walk, Westminster, London, S.W.1, "Research in Welded Structures and Pressure Vessels," D. S. MacFarlane, 6.30 p.m.

Wed., Nov. 22.—JAMES CLAYTON LECTURE: 1, Birdcage Walk, Westminster, London, S.W.1, "Reflections on the Institution's Role in Engineering Education," E. Giffen, 6 p.m. ★ MIDLAND BRANCH: Birmingham and Midland Institute, Paradise Street, Birmingham, Joint Meeting with the Local Branches of the Institutions of Civil and of Electrical Engineers, "Experimental Investigations of Space," J. A. Radcliffe, 6.30 p.m. ★ NORTH WESTERN BRANCH: Municipal College, Burnley, "Radar," T. R. Goode, 7.30 p.m. ★ EAST MIDLAND GRADUATES' SECTION: Technical College, Peterborough, "Industrial Instrumentation," M. Hamblin, 7.15 p.m. ★ LONDON GRADUATES' SECTION: Visit to L.T.E. Acton Railway Works, Bolls Lane, Acton, 2.15 p.m. ★ SOUTHERN GRADUATES' SECTION: College of Technology, Anglesea Road, Portsmouth, Film Show, "High Speed Flight, Part II," and "Schlieren," 6.45 p.m. ★ SOUTHERN GRADUATES' SECTION: Visit to Sperry Gyroscope Ltd., Bracknell, 2 p.m. ★ YORKSHIRE GRADUATES' SECTION: Visit to British Railways Ltd., Doncaster, 6.30 p.m.

Thurs., Nov. 23.—EASTERN BRANCH: University Engineering Laboratory, Cambridge, Repetition of James Clayton Lecture, "Reflections on the Institution's Role in Engineering Education," E. Giffen, 7.30 p.m. ★ SOUTHERN BRANCH: College of Technology, Anglesea Road, Portsmouth, "Electrical Aspects of Induction Heating and Melting," R. Buckley, 7 p.m. ★ WESTERN BRANCH: Queen's Building, Engineering Laboratories, The University, University Walk, Bristol, "Review of the Objectives and Some Development Problems of the Westland Rotodyne," G. S. Hislop, 7 p.m. ★ SOUTH WALES GRADUATES' SECTION: Afternoon visit to the South Wales Laboratories of the British Iron and Steel Research Association, Sketty Hall, Swansea.

Sat., Nov. 25.—WESTERN GRADUATES' SECTION: Visit to the Swindon Works, British Railways, Western Region, 10 a.m.

Mon., Nov. 27.—EDUCATION AND TRAINING GROUP: 1, Birdcage Walk, Westminster, London, S.W.1, Discussion on "The Effectiveness of Postgraduate Courses," opened by W. A. Tuplin, 6 p.m. ★ MIDLAND GRADUATES' SECTION: College of Engineering Technology, Rugby, Films, 7 p.m. ★ NORTH EASTERN GRADUATES' SECTION: Rutherford College of Technology, Northumberland Road, Newcastle upon Tyne, "Reactor Fuel Element Design," M. O. Engel, 6.30 p.m.

INSTITUTION OF PLANT ENGINEERS

Thurs., Nov. 23.—MERSEYSIDE AND NORTH WALES BRANCH: The Blossoms, Chester, "Refractories for Boilers and Furnaces—Construction and Maintenance," M. Ash, and N. W. Hinchcliffe, 7.15 p.m.

Mon., Nov. 27.—WEST AND EAST YORKSHIRE BRANCH: Hoddesdon Technical College, "Basic Electronics in Industry and Commerce," R. H. Garner, 7.30 p.m.

Tues., Nov. 28.—SOUTH WALES BRANCH: Electricity Showrooms, 62, Kingsway, Swansea, "Design for Maintenance," R. N. Dale, 7 p.m.

INSTITUTION OF PRODUCTION ENGINEERS

Mon., Nov. 20.—SHEFFIELD GRADUATE SECTION: Visit to Earle Cement Works, Hope, Derbyshire, and "The Handling of Materials for the Manufacture of Cement," 7 p.m. ★ MIDLANDS REGION: Craven Arms Hotel, High Street, Coventry, "Technique on Fine Boring," J. Judkins, 7 p.m.

Tues., Nov. 21.—NORTH WESTERN REGION: Reynolds Hall, Manchester College of Science and Technology, Sackville Street, Manchester, "Application of Metal Deposition," W. E. Ballard, 7.15 p.m. ★ SOUTH EASTERN REGION: Half-way House, Dunstable Road, Luton, "Static Switching Applied to Machine Tool Control," W. G. Turner, 7.30 p.m.

Wed., Nov. 22.—SOUTH EASTERN REGION: A.P.V., Crawley, "A Review of New Techniques in the Manipulation of Metals," G. G. Dewsnap, 7 p.m.

Thurs., Nov. 23.—NORTH WESTERN REGION: Grand Hotel, Hanley, Stoke-on-Trent, "Trade Unions and their Approach to Productivity," R. Slater, 7.30 p.m.

Fri., Nov. 24.—NORTH MIDLANDS REGION: Louis Room, St. James's Restaurant, St. James's Street, Derby, "Training Foremen," D. B. Beynon, 7 p.m.

INSTITUTION OF STRUCTURAL ENGINEERS

Mon., Nov. 20.—LANCASHIRE AND CHESHIRE BRANCH: New Civil Engineering Building, The University, Brownlow Hill, Liverpool, "Economics of Framed Structures," L. R. Crane, 6.30 p.m.

Thurs., Nov. 23.—11, Upper Belgrave Street, London, S.W.1, "Services and Air Conditioning for Tall Buildings," J. B. Kell, 6 p.m.

Tues., Nov. 21.—NORTHERN COUNTIES BRANCH: Cleveland Scientific and Technical Institution, Middlesbrough, "Transport in Urban Areas," C. D. Buchanan, 6.30 p.m.

JUNIOR INSTITUTION OF ENGINEERS

To-day, Nov. 17.—Pepys House, 14, Rochester Row, Westminster, London, S.W.1, Chairman's Address, "Some Notes on Early Marine Diesel Engines," E. E. Burrage, 7 p.m.

Fri., Nov. 24.—Pepys House, 14, Rochester Row, Westminster London, S.W.1, Annual General Meeting, 7 p.m.

NORTH-EAST COAST INSTITUTION OF ENGINEERS AND SHIPBUILDERS

Fri., Nov. 24.—Mining Institute, Newcastle upon Tyne, "An Evolution in Ship Control," H. E. H. Pain, 6.15 p.m.

PLASTICS INSTITUTE

To-day, Nov. 17.—MIDLANDS SECTION: James Watt Memorial Institute, Great Charles Street, Birmingham, 3, "Blow Moulding of Thermoplastics," M. C. Dixon, 6.30 p.m.

Tues., Nov. 21.—LONDON AND DISTRICT SECTION: Borough Polytechnic, London, S.E.1, Students' Lecture, 2.30 p.m.

Wed., Nov. 22.—WESTERN SECTION: Westinghouse Brake and Signals Company Ltd., Chippenham, Wilts., "Plastics in Railways," 7 p.m.

Fri., Nov. 24.—MIDLANDS SECTION, REINFORCED PLASTICS GROUP: James Watt Memorial Institute, Great Charles Street, Birmingham, 3, "Developments in Curing Systems for Polyester Resins," J. W. Cywinski, 7 p.m.

REINFORCED CONCRETE ASSOCIATION

To-day, Nov. 17.—SOUTH WALES AND MONMOUTHSHIRE BRANCH: South Wales Institute of Engineers, Park Place, Cardiff, "Reinforced Concrete from the Quarry Angle," A. R. Greenwood, 6 p.m.

Tues., Nov. 21.—SCOTTISH BRANCH: St. Enoch's Hotel, Glasgow, "Multi-Storey Flats at Blairdardie, Glasgow," H. McClusky, 6.30 p.m.

Thurs., Nov. 23.—WEST OF ENGLAND BRANCH: New School of Engineering, The University, Bristol, "Concrete from the Rough Board Shutter," A. J. Gordon, 6 p.m.

ROYAL INSTITUTION OF GREAT BRITAIN

Fri., Nov. 24.—21, Albemarle Street, London, W.1, "Seeing Atomic Defects in Metals," P. B. Hirsch, 9 p.m.

ROYAL INSTITUTION OF NAVAL ARCHITECTS

Thurs., Nov. 23.—10, Upper Belgrave Street, London, S.W.1, "Tug Propulsion Investigations," M. N. Parker, and J. Dawson, 4.45 p.m.